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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE  
DIVISION OF INSECTICIDE INVESTIGATIONS

A LIST OF ORGANIC SULPHUR COMPOUNDS  
(EXCLUSIVE OF MOTHPROOFING MATERIALS)  
USED AS INSECTICIDES

R. C. ROARK and R. L. BUSBEY

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USED AS INSECTICIDES

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## INTRODUCTION

Sulphur in various forms and combinations is one of the most valuable and widely used insecticides and fungicides. In the form of elemental sulphur it is applied to fruit trees and to ornamental plants, both as a dust and in suspension in water, for combating red spiders and certain fungous diseases. In the form of sulphides and polysulphides sulphur has varied uses in pest control. Sodium sulphide, calcium monosulphide, calcium polysulphide (lime-sulphur solution and dry lime-sulphur), and barium tetrasulphide are examples of this class. When sulphur is burned in air, sulphur dioxide is formed. This is probably the oldest insecticidal fumigant. Sulphuric acid and ferrous sulphate find widespread use as weed killers. The total quantity of sulphur consumed annually in the United States for pest control has been estimated to be 500,000 pounds calcium monosulphide, 43,000,000 pounds lime-sulphur (dry basis), and 30,000,000 pounds sulphur dust.

Of the numerous organic compounds of sulphur that are known, only carbon disulphide has been used extensively as an insecticide. Recently many sulphated and sulphonated fatty oils, aromatic hydrocarbons and alcohols have been proposed as wetting agents for use with insecticides, and some of these, while possessing no intrinsic insecticidal value, do contribute to the efficacy of a spray solution by altering its physico-chemical properties. New organic sulphur compounds are already assuming importance as commercial insecticides. Certain aliphatic thiocyanates derived from ethylene glycol form the basis of a proprietary fly spray and lauryl thiocyanate has been put on the market recently for use as a contact insecticide.

The United States Department of Agriculture has taken a leading part in the development of organic sulphur compounds as insecticides. Beginning in 1921 and continuing today, investigations have been made of a wide variety of compounds of this class. Aliphatic thiocyanates, sulphides, and disulphides and many heterocyclic compounds containing sulphur in the ring were first tested for their insecticidal action by workers in this Department. Partial reports of this work have been published by Neifert et al. (13)\* in 1925, by Roark and Cotton (18) in 1930, by Campbell et al. (1) in 1934, and by Cupples et al. (2) in 1935.

It is the purpose of this publication to catalog all organic compounds of sulphur that have been tested for insecticidal action or that have been proposed for use as insecticides, exclusive of mothproofing materials, of which a separate list is being prepared. References are included to those wetting agents containing sulphur that are used in conjunction with insecticides. References to the fungicidal and bactericidal action of organic sulphur compounds are also included.

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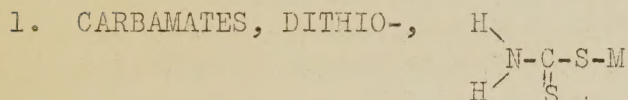
\* Numbers in parentheses refer to the publications listed on page 83.



The products in this list are classified according to their chemical nature. For example, all compounds containing the mercapto (SH) radical are grouped together, and similarly the thiocyanates, isothiocyanates, etc. Within each group the arrangement is alphabetical according to the system used in the index of Chemical Abstracts. With the exception of carbon disulphide, to which hundreds of references may be found, and of certain commonly used wetting agents, such as Turkey red oil, an effort has been made to list all references to the pesticidal use of every compound listed.

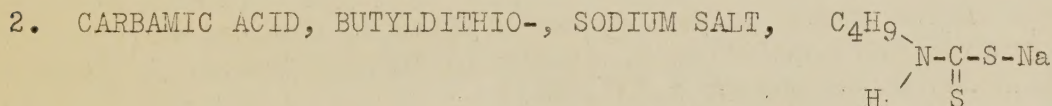
It is hoped that this publication will stimulate the testing of these organic sulphur compounds, and others that may be synthesized, against a wide variety of insects. The amazing possibilities of controlling pests with certain organic sulphur compounds may be shown with phenothiazine as an example. This compound is more toxic than rotenone to culicine mosquito larvae, being very effective at a concentration of 1 part per million of water (1, p. 1185).

#### DITHIOCARBAMIC ACID DERIVATIVES



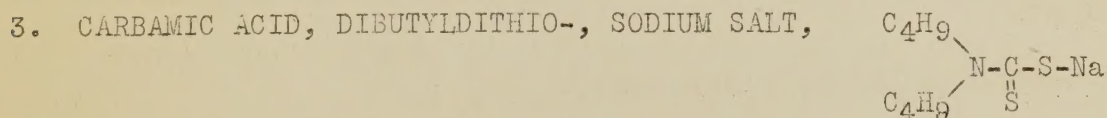
Synonym: Dithiocarbaminates

Dithiocarbaminates are used to destroy rust (Puccinia graminis) on wheat by spraying the young wheat with dilute solutions or dusting it with powdered preparations. (French patent 702,703.)



About 90 percent of aphids infesting plants sprayed with a 0.25 percent solution of sodium butyldithiocarbamate containing 0.5 percent of Perminal were dead in 24 hours after spraying. (Australian patent 8103/32.)

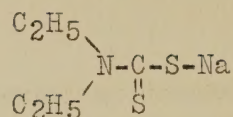
About 70 percent of the spores on barley were killed by soaking 30 minutes in water containing 0.1 percent sodium butyldithiocarbamate. (Australian patent 8103/32; U. S. patent 1,972,961.)



About 90 percent of aphids infesting plants sprayed with a 0.25 percent solution of sodium dibutyldithiocarbamate containing 0.5 percent of Perminal were dead in 24 hours after spraying. (Australian patent 8103/32.)

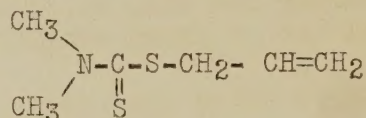


4. CARBAMIC ACID, DIETHYLDITHIO-, SODIUM SALT,



Ninety percent of aphids infesting plants sprayed with a 0.25 percent solution of sodium diethyldithiocarbamate containing 0.5 percent of Perminol were dead in 24 hours after spraying. (Australian patent 8103/32.)

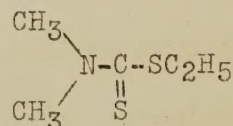
5. CARBAMIC ACID, DIMETHYLDITHIO-, ALLYL ESTER,



Freshly sawed pine dipped in an emulsion of allyldimethyldithiocarbamate and a sodium salt was not stained by fungi while untreated material was badly stained. Smut infested barley soaked for 30 minutes in a 0.1 percent solution of allyl dimethyldithiocarbamate and 0.25 percent of dibutyl ammonium oleate and then placed in a germinator for 48 hours showed no germination of spores. (Australian patent 8103/32; U. S. patent 1,972,961.)

Aphid infested potato plants were sprayed with 0.25 percent of allyl dimethyldithiocarbamate emulsified in water with a wetting agent. About 80 percent of the aphids were dead in 24 hours. (Australian patent 8103/32.)

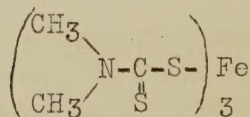
6. CARBAMIC ACID, DIMETHYLDITHIO-, ETHYL ESTER,



M.p. 2° C.; b.p. 252° C.

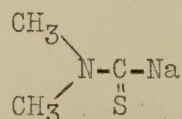
All but a trace of the spores on barley were killed by soaking 30 minutes in water containing 0.1 percent ethyl dimethyldithiocarbamate. (Australian patent 8103/32; U. S. patent 1,972,961.)

7. CARBAMIC ACID, DIMETHYLDITHIO-, FERRIC SALT,



Two tubes of a mixture of one part of finely divided ferric dimethyldithiocarbamate and 250 parts of sterile nutrient agar were inoculated with a pure culture of Aspergillus niger and two with a pure culture of Fomes annosus. In each case growth was inhibited. (Australian patent 8103/32; U. S. patent 1,972,961.)

8. CARBAMIC ACID, DIMETHYLDITHIO-, SODIUM SALT,



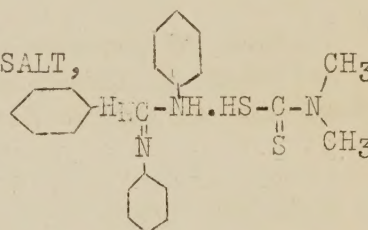
One-tenth cc. of a culture of Staphylococcus aureus in broth was added to 5 cc. of a 0.2 percent solution of sodium dimethyldithiocarbamate. After 15 minutes, neutral broth was inoculated with one drop of this mixture. No growth resulted when the culture was incubated at 37° for 48 hours.



Smut infested barley soaked for 30 minutes in a 0.1 percent solution of sodium dimethyldithiocarbamate at 40° C. and then placed in a germinator for 48 hours showed no germination of spores. (Australian patent 8103/32; U. S. patent 1,972,961.)

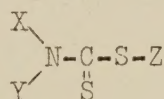
Aphid infested potato plants were sprayed with a 0.25 percent aqueous solution of sodium dimethyldithiocarbamate containing 0.5 percent of Perminol. Aphids began to fall within an hour and in 24 hours approximately 95 percent were dead. The above test repeated without the Perminol resulted in the death of more than 50 percent of the aphids in 24 hours. (Australian patent 8103/32.)

9. CARBAMIC ACID, DIMETHYLDITHIO-, TRIPHENYLGUANIDINE SALT,

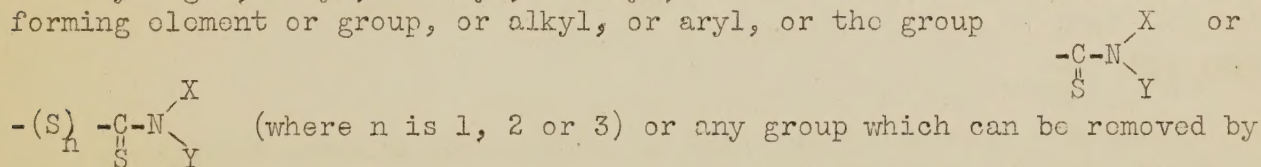


One part of triphenylguanidine dimethyldithiocarbamate in 250 parts of sterile nutrient agar inhibited the growth of Aspergillus niger and Fomes annosus. (Australian patent 8103/32; U. S. patent 1,972,961.)

10. CARBAMIC ACID, DITHIO-, DERIVATIVES,



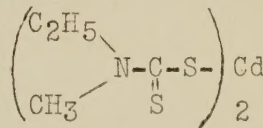
Dithiocarbamic acid derivatives are used as bactericides, fungicides and insecticides. The metal, amine or ammonium salts and thiuram sulphides are mentioned especially. In the formula, X is hydrogen, alkyl or aralkyl, Y is hydrogen, alkyl, aralkyl, or aryl, and Z is a metal or a basic salt-forming element or group, or alkyl, or aryl, or the group



hydrolysis with aqueous caustic soda with production of a sodium dithiocarbamate.

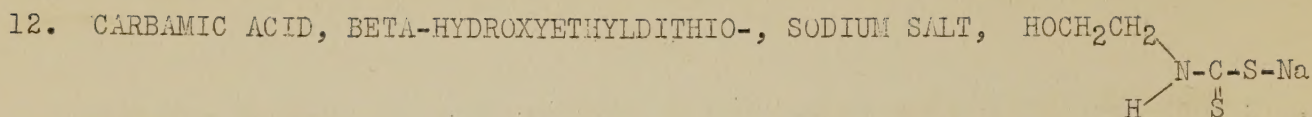
If Z is Na, K, Ca, NH<sub>4</sub>, methylammonium or dimethyl ammonium a water soluble product is formed; if Z is Zn, Hg, Cu or Fe a water insoluble product results. (Australian patent 8103/32; U. S. patent 1,972,961.)

11. CARBAMIC ACID, ETHYLMETHYLDITHIO-, CADMIUM SALT,

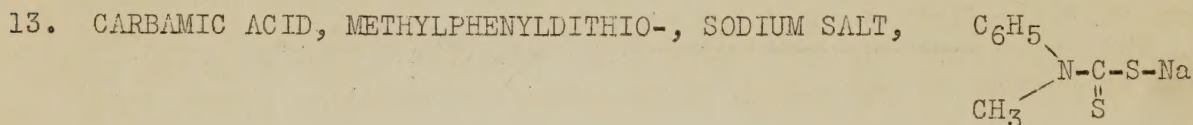


One part of cadmium methylethyldithiocarbamate in 250 parts of sterile nutrient agar inhibited the growth of Aspergillus niger and Fomes annosus. (Australian patent 8103/32; U. S. patent 1,972,961.)

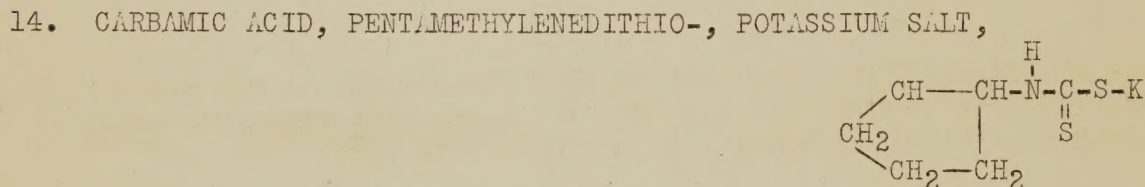




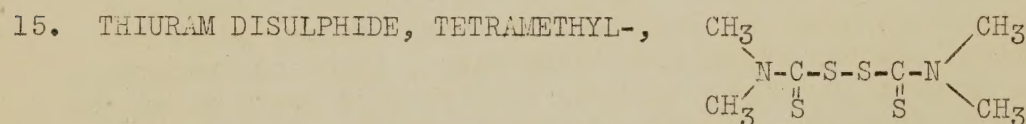
About 90 percent of aphids infesting plants sprayed with a 0.25 percent solution of sodium beta-hydroxyethyldithiocarbamate containing 0.5 percent of Perminal were dead in 24 hours after spraying. (Australian patent 8103/32.)



About 90 percent of aphids infesting plants sprayed with a 0.25 percent solution of sodium phenylmethyldithiocarbamate containing 0.5 percent of Perminal were dead in 24 hours after spraying. (Australian patent 8103/32.)

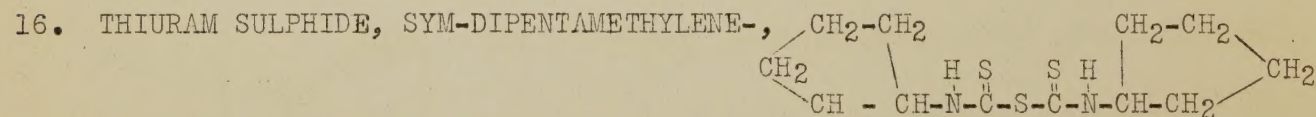


About 90 percent of aphids infesting plants sprayed with a 0.25 percent solution of potassium pentamethylenedithiocarbamate containing 0.5 percent of Perminal were dead in 24 hours after spraying. (Australian patent 8103/32.)



M.p. 146° C.

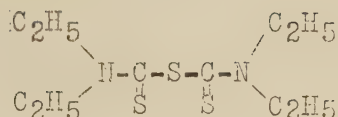
Two tubes of a mixture of one part of tetramethyl thiuram disulphide in 250 parts of sterile nutrient agar were inoculated with a pure culture of Aspergillus niger, and two tubes were inoculated with a pure culture of Fomes annosus. Growth was inhibited in both cases. Freshly sawn pine dipped in a saturated aqueous solution of tetramethyl thiuram disulphide and then stacked remained bright while the untreated material became badly stained. (Australian patent 8103/32; British patent 406,979; U. S. patent 1,972,961.)



Eighty percent of aphids infesting potato plants sprayed with 0.25 percent of dipentamethylene thiuram sulphide emulsified in water containing a wetting agent were dead in 24 hours after spraying. (Australian patent 8103/32.)

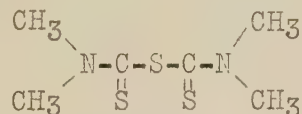


17. THIURAM SULPHIDE, TETRAETHYL-,



About 50 percent of the spores on barley were killed by soaking 30 minutes in water containing 0.1 percent tetraethyl thiuram monosulphide. (Australian patent 8103/32; U. S. patent 1,972,961.)

18. THIURAM SULPHIDE, TETRAMETHYL-,



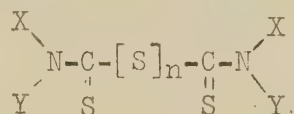
M.p. 104° C.

Freshly sawed pine dipped in a solution saturated with tetramethylthiuram monosulphide and tetramethylthiuram disulphide was not stained by fungi while untreated material was badly stained. Cloth impregnated with a warm 0.1 percent solution of tetramethylthiuram monosulphide and stored under warm, damp conditions remained in good condition while an untreated sample was affected with mold. Wallboard made from pine wood, which was impregnated with a boiling 0.2 percent solution of tetramethylthiuram monosulphide and then placed in test tubes containing growing cultures of Fomes Annosus for three weeks at 25° C., lost no weight and showed no signs of decay while untreated samples showed considerable shrinking and signs of decay. (British patent 406,979.)

Smut infested barley soaked for 30 minutes in water saturated with tetramethylthiuram monosulphide at 40° C. and then placed in a germinator for 48 hours showed only a trace of germination. A high percentage of spores on seed soaked in water germinated. When this procedure was repeated with 0.1 percent tetramethylthiuram monosulphide, approximately 50 percent of the spores were killed. (Australian patent 8103/32; U. S. patent 1,972,961.)

Potato plants infested with aphids were sprayed with an approximately 0.1 percent solution of tetramethylthiuram monosulphide containing 0.5 percent of Permal as a wetting agent. Within 30 minutes the aphids began to fall and after 24 hours about 95 percent were dead. (Australian patent 8103/32.)

19. THIURAM SULPHIDES,

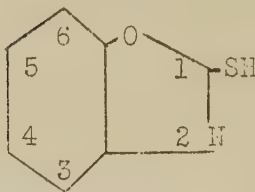


X is alkyl or aralkyl, Y is alkyl, aralkyl or aryl, or X and Y together form a methylene chain, and n is 1, 2 or 3. These compounds protect wood, textiles, paper and the like from fungoid growths, etc. They may be applied in an aqueous medium or in an organic solvent or in an aqueous emulsion of the solution in an organic solvent. Application may be by immersion, spraying or other means. Wetting agents, etc., may be added. These sulphides possess disinfectant, fungicidal, bactericidal, insecticidal and sterilizing properties. (British patent 406,979.)



MERCAPTANS

20. BENZOXAZOLE, 1-MERCAPTO-,



Synonym: 2-thiobenzoxazol.

A concentration of 1:10,000 in water killed 26 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

21. n-BUTYL MERCAPTAN,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{SH}$

B.p.  $98^\circ$

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 67 mg./liter. (Roark and Cotton, 18, p. 33.)

A dosage of 5 lbs./1000 cu. ft. as a fumigant against the flour weevil (Tribolium confusum Fab.) the granary weevil (S. granarius L.) and larvae of the Indian meal moth (Plodia interpunctella Hbn.) killed 100 percent. A dosage of 2-1/4 lbs./1000 cu. ft. killed 100 percent of rice weevils (S. oryza L.) (Neifert et al., 13, p. 8.)

Butyl mercaptan was somewhat repellent to house flies (Musca domestica L.), green bottle flies (Lucilia spp.) and black blowflies (Phormia regina Meig.) (Laake et al., 7, p. 4.)

Butyl mercaptan was repellent to screw-worm flies (Cochliomyia macellaria Fab.) (Farman et al., 14, pp. 14, 25.)

n-Butyl mercaptan admixed with HCN and used as a fumigant had little or no toxicity to the red scale on lemons. (Cupples et al., 2.)

22. ETHYL MERCAPTAN,  $\text{CH}_3\text{CH}_2\text{SH}$

Synonyms: Äthanthiol; Äthylmercaptan

B.p.  $36.2^\circ$

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 17 mg./liter. (Roark and Cotton, 18, p. 32.)

A dosage at the rate of 33 lbs./1000 cu. ft. as a fumigant was fatal against the rice weevil (Sitophilus oryza L.), the flour weevil (Tribolium confusum Fab.), the granary weevil (S. granarius L.), and larvae of the Indian meal moth (Plodia interpunctella Hbn.) in glass flasks. (Neifert et al., 13, p. 8.)



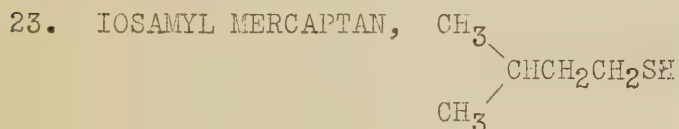
Ethyl mercaptan has no effect on red spiders (Tetranychus telarius) and also failed to kill adult white flies. (Speyer, 20, p. 54.)

Ethyl mercaptan was somewhat attractive to house flies (Musca domestica L.) but slightly repellent to green bottle flies (Lucilia spp.) (Laake et al., 7, p. 4.)

Ethyl mercaptan increased the attractiveness of beef liver to screw-worm flies (Cochliomyia macellaria Fab.) (Parman et al., 14, pp. 14, 25.)

Six and eight hundred twenty-six thousandths mg. per liter, equivalent to 109.9 millionths of a gram molecule, of ethyl mercaptan were required to kill house flies (Musca domestica L.) in 400 minutes. (Moore, 9.)

Ethyl mercaptan admixed with HCN and applied as a fumigant to red scale on lemons showed little or no toxicity. (Cupples et al., 2.)

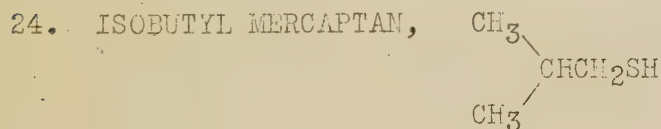


Synonyms: 2-Methylbutanthiol-4; 3-Methylbutanthiol-1

B.p. 129.5°

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 84 mg./liter. (Roark and Cotton, 18, p. 33.)

Isoamyl mercaptan admixed with HCN in fumigation tests against red scale (Chrysomphalus Aurantii Mask.) on lemons showed slight or no toxicity. (Cupples, et al., 2.)



Synonyms: 2-Methylpropanthiol-1

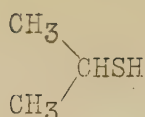
B.p. 88°

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 33 mg./liter. (Roark and Cotton, 18, p. 33.)

In fumigation tests against red scale (Chrysomphalus aurantii mask.) on lemons, scale exposed to a saturated atmosphere for 25 minutes at room temperature showed a survival (resistant stages) of 3.2 percent. In another test 2 cc. of the compound were vaporized into a 50 gallon barrel containing infected lemons; the lemons were removed after 25 minutes, the scale showing a survival of 89 percent. (Cupples et al., 2.)



25. ISOPROPYL MERCAPTAN,



Synonyms: Propanthiol-2; sek.-propylmercaptan

B.p. 60° C.

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 160 mg./liter. (Roark and Cotton, 18, p. 32.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

26. 2-NAPHTHYL MERCAPTAN,



Synonym: Beta-thionaphthol

M. p. 81° C.

Commercial beta-thionaphthol with sufficient  $\text{NH}_4\text{OH}$  to render it soluble was sprayed on Aphis rumicis on nasturtium plants. The concentration necessary to kill 95 percent or more of the aphids was 1 while the concentration tolerated by nasturtium plants was 0.5 gram per 100 cc. (Richardson and Smith, 17.)

When dusted on bean foliage thio-betanaphthol caused serious burning. (Mocre and Campbell, 10.)

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 25 out of 50 larvae in 88 minutes and all 50 in 180 minutes. In another test, 1:40,000 killed 25 out of 50 larvae in 25 minutes and the clear filtrate from the same solution killed 25 out of 50 larvae in 126 minutes. A concentration of 1:100,000 killed 25 out of 50 larvae in 228 minutes, 42 in 8 hours, and 46 in 20 hours. A concentration of 1:200,000 killed only 1 out of 50 larvae in 20 hours. (Campbell et al., 1.)

27. PERCHLOROMETHYL MERCAPTAN,  $\text{CCl}_3\text{SCl}$

B.p. 149°

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 240 mg./liter. (Roark and Cotton, 18, p. 33.)



A dosage of 5.2 lbs./1000 cu. ft. killed 100 percent of Sitophilus granarius in glass flasks but was ineffective against S. oryza, Tribolium and Plodia larvae. (Neifert et al., 13, p. 8, where it is incorrectly called perchloromethyl mercaptol.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed moderate toxicity both alone and as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

Perchloromethylmercaptan admixed with 0.2 percent HCN in air shortened the time required for 100 percent kill of ladybird beetles (Hippodamia convergens Guerin) to 15 minutes or less. Two-tenths percent HCN alone required 25 minutes. (Pratt et al., 15.)

28. PHENYL MERCAPTAN,



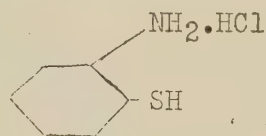
Synonym: thiophenol.

B.p. 172.5° C.

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

Thiophenol at a concentration of 0.20 percent, by weight, in air gave a partial kill of ladybird beetles (Hippodamia convergens Guerin) in 30 minutes. Five hundredths percent thiophenol admixed with 0.2 percent HCN shortened the time necessary for a 100 percent kill of the beetles to 20 minutes; 0.10 percent cut the time to 10 minutes. 0.2 percent HCN alone required 25 minutes. (Pratt et al., 16.)

29. PHENYL MERCAPTAN, o-AMINO-, HYDROCHLORIDE,



Synonym: o-aminothiophenol hydrochloride

A concentration of 1:10,000 in water killed 91 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

30. PHENYL MERCAPTAN, o-AMINO-4-CHLORO-, HYDROCHLORIDE,



Synonym: 2-Amino-4-chlorothiophenol hydrochloride

A concentration of 1:10,000 in water killed 82 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)



31. PHENYL MERCAPTAN, p-AMINO-, HYDROCHLORIDE,



Synonym: p-Aminothiophenol hydrochloride

A concentration of 1:40,000 in water killed 2 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

32. PHENYL MERCAPTAN, p-BROMO-,



Synonym: p-Bromothiophenol

M.p. 75° C.

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 25 out of 50 larvae in 100 minutes and all 50 in 180 minutes. In another test 1:40,000 killed 25 out of 50 larvae in 33 minutes and the clear filtrate from the same solution killed 25 out of 50 larvae in 31 minutes. A concentration of 1:100,000 killed 25 out of 50 larvae in 386 minutes, 33 in 8 hours, and 42 in 20 hours. At 1:200,000, only 9 larvae out of 50 were killed in 8 hours and 10 in 20 hours. (Campbell et al., 1.)

33. PHENYL MERCAPTAN, p-NITRO-,



Synonym: p-Nitrothiophenol

M.p. 77° C.

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

34. n-PROPYL MERCAPTAN,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{SH}$

Synonyms: Propanthiol-1; prim.-Propylmercaptan

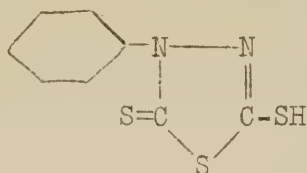
B.p. 68°

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 48 mg./liter. (Roark and Cotton. 18, p. 32.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)



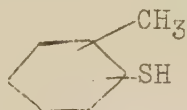
35. DELTA<sup>2</sup>-1,3,4-THIODIAZOLINE-2-MERCAPTAN, 4-PHENYL-5-THIO-,



Synonym: N-Phenyldithiopseudobiazolone mercaptan

A concentration of 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

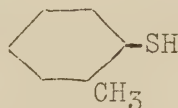
36. TOLYL MERCAPTAN,



Synonym: thiocresol

Thiocresol is used to increase the floatability on water of Paris Green for killing Anopheline larvae. (U. S. patent 1,942,532.)

37. o-TOLYL MERCAPTAN,



Synonym: o-Thiocresol

M.p. 15° C.

Fumigation tests against red scale (*Chrysomphalus aurantii* Mask.) on lemons showed slight or no toxicity as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

38. p-TOLYL MERCAPTAN,



Synonym: p-Thiocresol

M.p. 43° C.

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 25 out of 50 larvae in 51 minutes and all 50 in 96 minutes. In another test, 1:40,000 killed 25 out of 50 larvae in 29 minutes and the clear filtrate from the same solution killed 25 out of 50 in 40 minutes. A concentration of 1:100,000 killed 25 out of 50 larvae in 126 minutes and all 50 within 8 hours. A concentration of 1:200,000 killed 25 out of 50 larvae in 214 minutes, 45 in 8 hours and 49 in 20 hours. (Campbell et al., 1.)

MONOSULPHIDES

39. ALLYL SULFIDE,  $\text{CH}_2=\text{CHCH}_2\text{-S-CH}_2\text{CH}=\text{CH}_2$

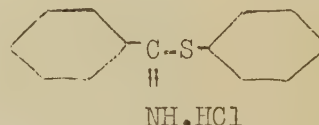
Synonym: Diallylsulfid

B.p.  $138.7^\circ \text{C}$ .

The maximum concentration, 444 mg./liter, tested as a fumigant against rice weevils (Sitophilus oryza L.) in wheat killed 60 out of 100 in 24 hours. (Roark and Cotton, 18, p.33.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

40. BENZIMIDOPHENYL SULPHIDE, HYDROCHLORIDE,



Synonym: Benzimido-thiophenylether hydrochloride

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 25 out of 50 larvae in 360 minutes, 28 in 8 hours, and 39 in 20 hours. (Campbell et al., 1.)

41. n-BUTYL SULPHIDE,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{-S-CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

B.p.  $182^\circ \text{C}$ .

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

42. CYANOGEN SULPHIDE,  $\text{CN-S-CN}$

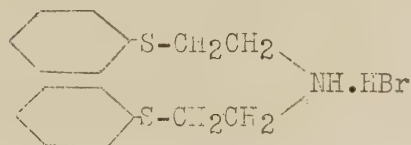
Subl.  $30-40^\circ \text{C}$ .

M.p.  $60^\circ \text{C}$ .

In tests as a fumigant against the rice weevil (Sitophilus oryza L.), the granary weevil (S. granarius L.) the flour weevil (Tribolium confusum Fab.) and Plodia larvae no insects were killed by a concentration of 1/4 lb./1000 cu. ft. (Neifert et al., 13, p. 8.)



43. DIETHYLAMINE, 2, 2'-PHENYLMERCAPTO-, HYDROBROMIDE,



Synonym: Imino diethylene thiophenylether hydrobromide

A concentration of 1:10,000 in water killed 48 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

44. ETHYLENE GLYCOL, DITHIO, BISPHENYL ETHER,



Synonym: Dithiophenyl ethylene, dithiophenyl ethane

A concentration of 1:10,000 in water killed 18 percent of culicine mosquito larvae in 9 hours. (Campbell et al., 1.)

45. ETHYL SULPHIDE,  $\text{CH}_3\text{CH}_2\text{-S-CH}_2\text{CH}_3$

Synonym: Diäthylsulphid

B.p.  $91.6^\circ \text{C}$ .

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 419 mg./liter. (Roark and Cotton, 18, p.33.)

The lethal concentration as a fumigant in glass flasks against the rice weevil (S. oryza L.) is 7.3 lbs./1000 cu. ft.; against the granary weevil (S. granarius L.) the same; against the flour weevil (Tribolium confusum Fab.) 6 lbs./1000 cu. ft. (Neifert et al., 13, p.8.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

46. ISOBUTYL SULPHIDE,  $\begin{array}{c} \text{CH}_3 \\ \diagdown \\ \text{CH} \\ \diagup \\ \text{CH}_3 \end{array} \text{CH}_2\text{-S-CH}_2\text{CH} \begin{array}{c} \text{CH}_3 \\ \diagup \\ \text{CH} \\ \diagdown \\ \text{CH}_3 \end{array}$

Synonym: Diisobutylsulphid

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 334 mg./liter. (Roark and Cotton, 18, p. 33.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

47. METHYL SULPHIDE,  $\text{CH}_3\text{-S-CH}_3$

Synonym: Dimethylsulphid

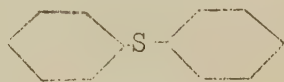
B.p.  $36.2^\circ$

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 425 mg./liter. (Roark and Cotton, 18, p. 33.)

A dosage of 18 lbs./1000 cu. ft. kills 100 percent of rice weevils (S. oryza L.) and granary weevils (S. granarius L.) and a dosage of 16-1/2 lbs./1000 cu. ft. kills 100 percent of the flour weevil (Tribolium confusum Fab.). (Neifert et al., 13, p. 8.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed moderate toxicity. (Cupples et al., 2.)

48. PHENYL SULPHIDE,



Synonym: Diphenyl sulphide

A mixture of 3 to 10 percent of diphenylsulphide, 0.2 to 1 percent of a wetting agent and/or adhesive and 96.8 to 99 percent of an inert material such as prepared chalk, talc, kieselguhr, etc., may be used for dusting wheat to destroy rust (Puccinia graminis). (French patent 702,703.)

49. n-PROPYL SULPHIDE,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{-S-CH}_2\text{CH}_2\text{CH}_3$

Synonym: Dipropylsulphide

B.p.  $142^\circ \text{C}$ .

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 244 mg./liter. (Roark and Cotton, 18, p. 33.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

50. SULPHIDE, BENZYL TOLYL,  $\text{CH}_3\text{C}_6\text{H}_4\text{SCH}_2\text{C}_6\text{H}_5$

Synonyms: thiocresyl benzyl ether; Thiokresylbenzyläther

An insecticide and fungicide. (German patent 363,656.)

A mixture of 5 parts of thiocresylbenzyl ether, 5 parts of cyclohexanone and 5 parts of tetrahydronaphthalene mixed with 85 parts of talc serves to combat bird lice. A solution of 4 parts of thiocresylbenzyl ether, 2 parts of cyclohexanone and 2 parts of tetrahydronaphthalene in 500 parts of 75-85 percent alcohol may be used against dog fleas. (British patent 326,803; French patent 684,447; German patent 496,281.)

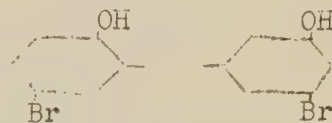


51. SULPHIDE, BIS(3-BROMO-2-HYDROXY-5-METHYLPHENYL)-,



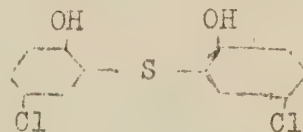
52. A polish containing 1 percent of this compound kills staphylococci in a few hours. (British patent 349,004.)

52. SULPHIDE, BIS(5-BROMO-2-HYDROXYPHENYL)-,



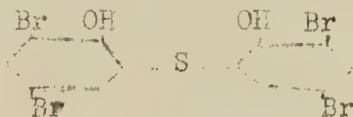
One part of this with 99 parts of talcum is useful for combating mildew on roses. A 5 percent solution of this compound in normal caustic soda is used to impregnate dead wood. A mixture of 10 parts of this compound, 80 parts of talcum and 10 parts of isobutyl-naphthalene sodium sulphonate is suitable for treating seed grain. (British patent 349,004.)

53. SULPHIDE, BIS(5-CHLORO-2-HYDROXYPHENYL)-,



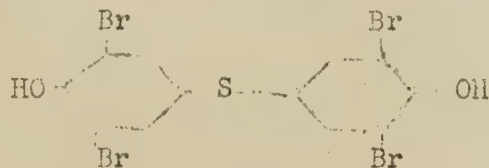
A mixture of 2 parts of this compound and 98 parts face powder suppresses the development of *Bacillus pyocyaneus*. Fabrics impregnated with 2 percent of bis-(2-hydroxy-5-chlorophenyl)-sulphide are rendered mothproof. One hundred parts by weight of wool, well wetted, are impregnated in a cold or heated bath of about 1:20 of the sodium salt of this compound. The bath is exhausted in a short time and the substance fixed on the fiber. The wool is rinsed or acidified in the customary manner and dried. Ten parts by weight of bis-(2-hydroxy-5-chlorophenyl)-sulphide and 10 parts by weight of soft or potash soap are made up with water, after the addition of the requisite amount of alkali, to 100 parts. A 2 percent solution of this mixture is employed for combating different animal pests. (British patent 349,004.)

54. SULPHIDE, BIS(3,5-DIBROMO-2-HYDROXYPHENYL)-,



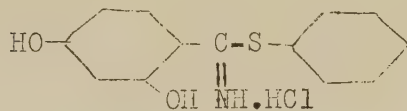
This compound at 1:5,000,000 kills staphylococci. Fabrics impregnated with 2 percent of bis-(2-hydroxy-3, 5-dibromophenyl)-sulphide are rendered mothproof. (British patent 349,004.)

55. SULPHIDE, BIS(3,5-DIBROMO-4-HYDROXYPHENYL)-,



The sodium salt of this compound at 1:100,000 arrests the growth of staphylococci. (British patent 349,004.)

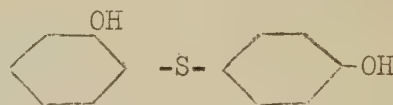
56. SULPHIDE, 2,4-DIHYDROXYBENZIMIDO PHENYL, HYDROCHLORIDE,



Synonym: 2,4-Dihydroxybenzimidophenyl sulphide hydrochloride

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 17 out of 50 larvae in 8 hours and 30 out of 50 in 20 hours. (Campbell et al., 1.)

57. SULPHIDE, 2,4'-DIHYDROXYBISPHENYL-,



Synonym: 2,4'-dihydroxydiphenyl sulphide

This compound possesses bactericidal, fungicidal and insecticidal properties. (British patent 349,004.)

58. SULPHIDE, ETHYLPROPYL,  $\text{CH}_3\text{CH}_2\text{-S-C}_3\text{H}_7$

Synonyms: thioethyl propyl ether; Thioäthylpropyläther

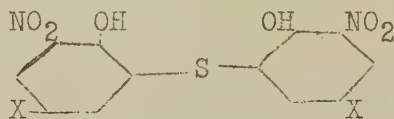
An insecticide and fungicide. (German patent 363,656.)

59. SULPHIDE, ETHYLTOLYL,  $\text{CH}_3\text{CH}_2\text{SC}_6\text{H}_4\text{CH}_3$

Synonyms: thioethyl cresyl ether; Thioäthylkresyläther

An insecticide and fungicide. (German patent 363,656.)

60. SULPHIDE, BIS(5-HALOGENO-2-HYDROXY-3-NITROPHENYL)-,



These compounds possess bactericidal, fungicidal and insecticidal properties. (British patent 349,004.)

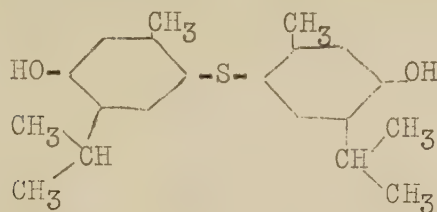
61. SULPHIDE, BETA-HYDROXYETHYL-,  $\text{HOCH}_2\text{CH}_2\text{-S-CH}_2\text{CH}_2\text{OH}$

B.p. 184° C.

A concentration of 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

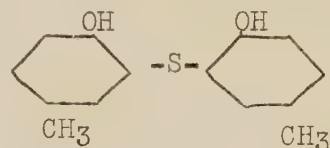


62. SULPHIDE, BIS(4-HYDROXY-5-ISOPROPYL-2-METHYLPHENYL)-,



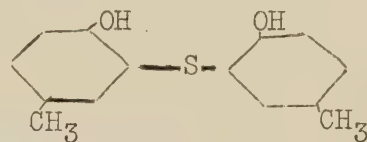
At 1:100,000 the sodium salt of this compound arrests the growth of staphylococci and kills them in about 5 hours. (British patent 349,004.)

63. SULPHIDE, BIS(2-HYDROXY-5-METHYLPHENYL)-,



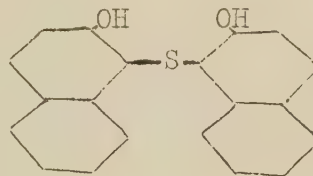
Ten parts by weight of bis-(2-hydroxy-5-methylphenyl)-sulphide are dissolved in 55 parts by weight of normal caustic soda lye and a solution of ten parts by weight of potash soap dissolved in 25 parts by weight of water is added. This preparation, when used for combating animal pests, is diluted with water to 1.5 percent. (British patent 349,004.)

64. SULPHIDE, BIS(4-HYDROXY-3-METHYLPHENYL)-,



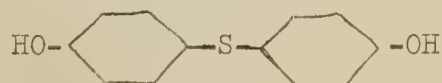
Ten parts by weight of bis-(4-hydroxy-3-methylphenyl)-sulphide are dissolved in 55 parts by weight of normal caustic soda lye and a solution of 10 parts by weight of potash soap dissolved in 25 parts by weight of soda is added. This preparation, when used for combating animal pests, is diluted with water to 1.5 percent. (British patent 349,004.)

65. SULPHIDE, BIS(2-HYDROXYNAPHTHYL)-



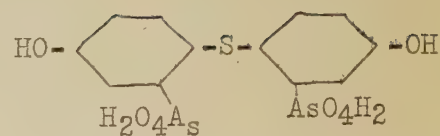
This compound in solution at 1:300,000 kills staphylococci in about 5 hours. It also possesses fungicidal and insecticidal properties. (British patent 349,004.)

66. SULPHIDE, BIS(4-HYDROXYPHENYL)-,



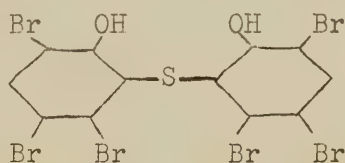
This compound possesses bactericidal, fungicidal and insecticidal properties. (British patent 349,004.)

67. SULPHIDE, BIS(4-HYDROXYPHENYL-2-ARSENIC ACID)-,



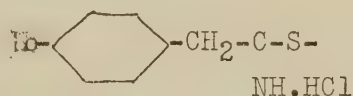
Three parts by weight of bis(4-hydroxyphenyl-2-arsenic acid)-sulphide and 97 parts by weight of talcum are finely powdered. This preparation may be dusted on growing plants, such as roses, for combating the mildew on roses. (British patent 349,004.)

68. SULPHIDE, BIS(2-HYDROXY-3, 5, 6-TRIBROMOPHENYL)-,



This compound at 1:1,000,000 kills staphylococci. (British patent 349,004.)

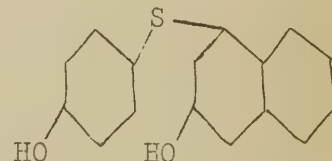
69. SULPHIDE, p-HYDROXYPHENYLACETIMIDO PHENYL, HYDROCHLORIDE,



Synonym: p-Hydroxyphenylacetimido-thiophenylether hydrochloride

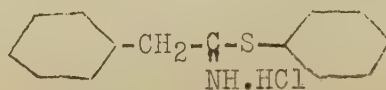
A concentration of 1:100,000 in water killed 56 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

70. SULPHIDE, 4-HYDROXYPHENYL-3-HYDROXY-1-NAPHTHYL,



This compound possesses bactericidal, fungicidal and insecticidal properties. (British patent 349,004.)

71. SULPHIDE, PHENYLACETIMIDO PHENYL, HYDROCHLORIDE,

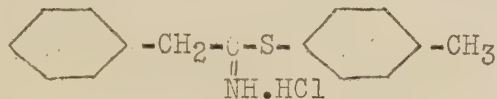




Synonym: Phenylacetimido-thiophenylether hydrochloride

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 25 out of 50 larvae in 240 minutes, 32 in 8 hours, and 46 in 20 hours. (Campbell et al., 1.)

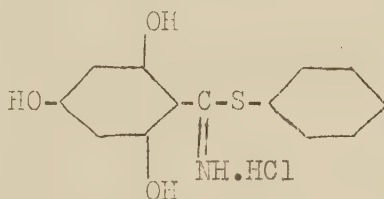
72. SULPHIDE, PHENYLACETIMIDO p-TOLYL, HYDROCHLORIDE,



Synonym: Phenylacetimido-thio-p-tolylether hydrochloride

A concentration of 1:100,000 in water killed 95 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

73. SULPHIDE, 2, 4, 6-TRIHIDROXYBENZIMIDO PHENYL, HYDROCHLORIDE,



Synonym: 2,4,6-trihydroxybenzimido thiophenylether, hydrochloride

A concentration of 1:10,000 in water killed 22 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

74. SULPHIDES.

Synonyms: thioethers; Thioether

Alkyl-, aryl- and aralkylthioethers possess intensive fungicidal and insecticidal activity. They may be used in liquid or vapor form, as pastes, powders obtained by absorption on porous material, soaps, salves, or solutions in alcohol, ethyl acetate, etc., either with or without other substances. (German patent 363,656.)

Mixtures of sulphides with cyclohexanone and tetrahydronaphthalene have an insecticidal action. The mixtures may be used either as such or as solutions in organic solvents or as powders obtained by absorption on pulverulent materials such as talc, diatomaceous earth, etc. Concentrations of about 2 percent and upwards may be employed. (British patent 326,803; French patent 684,447; German patent 496,281.)

75. SULPHIDES, BIS(BENZYLHYDROXYARYL)-,

(British patent 349,004.)

76. SULPHIDES, BIS(CYANOHYDROXYARYL)-,

(British patent 349,004.)

77. SULPHIDES, BIS(HALOGENOHYDROXYARYL)-,

(British patent 349,004.)

78. SULPHIDES, BIS(HYDROXYARYL)-,

As aryl residues may be specified phenyl, naphthyl and similar residues, and in addition to the two hydroxyl groups, the compounds may contain further substituents such as halogen, alkyl, aralkyl, aryl or additional hydroxyl groups or nitro, amino or alkoxy groups. These compounds possess bactericidal, fungicidal and insecticidal properties. (British patent 349,004.)

79. SULPHIDES, BIS(HYDROXYARYL), ARSENIC ACIDS OF

(British patent 349,004.)

80. SULPHIDES, BIS(POLYHYDROXYARYL)-,

Disinfecting or sterilizing preparations comprise a bis(polyhydroxyaryl)-sulphide diluted with a solid, semi-solid or liquid diluent. (British patent 349,004.)

DISULPHIDES

81. n-AMYL DISULPHIDE,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{-S-S-CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

82. CARBON DISULPHIDE,  $\text{CS}_2$

B.p.  $46^\circ$

The concentration of carbon disulphide toxic to wireworms (genus Agriotes) is 39.9 to 30.4 mg. per liter equivalent to 526-400 millionths of a gram molecule per liter of air in 1000 minutes at  $15^\circ \text{C}$ . (Tattersfield and Roberts, 20.)

The median lethal concentration as a fumigant for wireworms (Limonius (Pheletes) californicus Mann.) (the amount necessary for 50 percent mortality) was 31.50 mg. per liter. (Lehman, 8, p. 1050.)

The minimum toxic concentration to Aphis rumicis was more than 5 gm. per 100 cc. and the tolerance of nasturtium less than 2 gm. per 100 cc. (Richardson and Smith, 16, p. 6.)



Carbon disulphide was slightly repellent to the screw-worm fly (Cochliomyia macellaria Fab.). (Parman et al., 14, p. 14.)

Carbon disulphide was slightly repellent to house flies (Musca domestica L.) and green bottle flies (Lucilia spp.). (Laake et al., 7, p. 4.)

A saturated atmosphere of carbon disulphide at room temperature will kill Japanese beetle larvae and prevent the eggs from hatching when they are exposed to its action for a few minutes. A concentration of 4 parts carbon disulphide in 100,000 parts air is lethal to these stages within 24 hours at 80° F. At 60° F., a minimum period of 72 hours is required and at 40° C. a minimum period of 120 hours must be used to insure the destruction of the insect. (Fleming, 4, p. 813.)

A dilute emulsion of carbon disulphide has proved to be one of the best insecticides for the soil-infesting stages of the Japanese beetle. When submerged in the emulsion, the following concentrations were normally required to kill these stages within 24 hours at 65° C.:

Eggs -----	0.01 percent
First-instar larvae	0.02 "
Second " "	0.03 "
Third " "	0.03 "
Pupae -----	0.04 "

With dilute emulsion the most satisfactory results were obtained at 65-70° F. with the treatment prolonged for 24 hours. (Fleming, 4, p. 815.)

Twenty-one and eighty hundredths mg. per liter of carbon disulphide were required to kill house flies (Musca domestica L.) in 400 minutes. (Moore 9.)

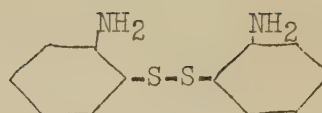
Carbon disulphide at .10 percent concentration had no effect on the time to kill 100 percent of ladybird beetles (Hippodamia convergens Guerin) when mixed with .20 percent HCN. (Pratt et al., 15.)

The lethal concentration as a fumigant in glass flasks against the rice weevil (Sitophilus oryza L.) is 2.3 lbs./1000 cu. ft.; against the granary weevil (S. granarius L.) 2.3 lbs./1000 cu. ft.; against the flour weevil (Tribolium confusum Fab.) 2.3 lbs./1000 cu. ft.; and against the larvae of the Indian meal moth (Plodia interpunctella Hbn.) 2 lbs./1000 cu. ft. (Neifert et al., 13, p. 17.)

A concentration exceeding 5 percent is necessary to kill aphids, where as a solution containing less than 2 percent injured the nasturtium plant. (Richardson and Smith, 16.)

Moderately toxic to red scale on lemons. (Cupples et al., 2.)

83. DISULPHIDE, BIS(o-AMINO-PHENYL)-,

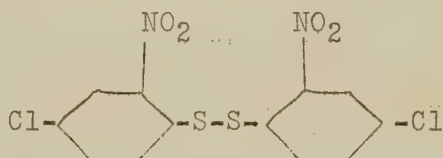


Synonym: intramine; bis(2-aminophenyl) disulphide

M.p. 85-86° C.

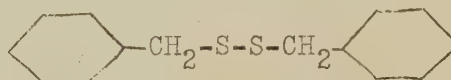
A concentration of less than 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

84. DISULPHIDE, BIS(4-CHLORO-2-NITROPHENYL)-,



A concentration of 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

85. DISULPHIDE, DIBENZYL,



M.p. 71-72° C.

A concentration of 1:10,000 in water killed 25 percent of culicine mosquito larvae in 9 hours. (Campbell et al., 1.)

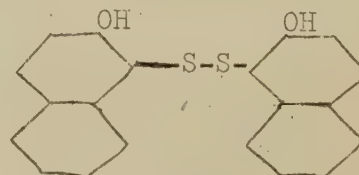
86. DISULPHIDE, ETHYL,  $\text{CH}_3\text{CH}_2\text{-S-S-CH}_2\text{CH}_3$

Synonym: Diethyl-disulphide

B.p. 153.5°

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 79 mg./liter. (Roark and Cotton, 18, p. 33.)

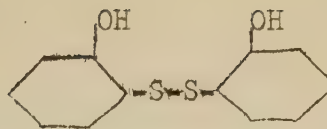
87. DISULPHIDE, BIS(2-HYDROXY-1-NAPHTHYL)-,



This compound possesses bactericidal, fungicidal and insecticidal properties. (British patent 349,004.)



88. DISULPHIDE, BIS(2-HYDROXYPHENYL)-,



T

This compound possesses bactericidal, fungicidal and insecticidal properties. (British patent 349,004.)

89. DISULPHIDE, METHYL,  $\text{CH}_3\text{-S-S-CH}_3$

Synonym: Dimethyldisulphide

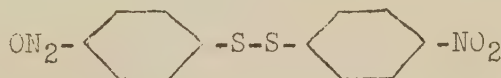
B.p.  $118^\circ$

The minimum concentration, 21 mg./liter, tested as a fumigant against rice weevils (Sitophilus oryza L.) in wheat killed 100 percent after exposure for 24 hours. (Roark and Cotton, 18, p. 33.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone at a concentration of 9.4 mg. per liter of air for 25 minutes or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

Beet seed is treated before sowing with 0.05 percent adsorbate of dimethyldisulphide on kieselguhr to prevent soil nematode (Heterodera schachtii) larvae from slipping out of their cysts until the beet plants have become sufficiently strong to withstand their attack. (British patent specification 249,830.)

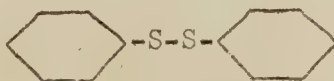
90. DISULPHIDE, BIS(p-NITROPHENYL)-,



M.p.  $180.5^\circ \text{ C.}$

A concentration of less than 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

91. DISULPHIDE, PHENYL,



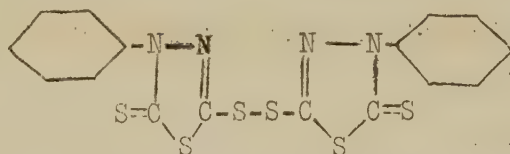
Synonym: Diphenyl disulphide

M.p.  $61^\circ \text{ C.}$

A concentration of 1:10,000 in water killed 60 percent of culicine mosquito larvae in 9 hours. (Campbell et al., 1.)

A mixture of 3 to 10 percent of diphenyl disulphide, 0.2 to 1 percent of a wetting agent and/or adhesive and 96.8 to 89 percent of an inert material such as prepared chalk, talc, kieselguhr, etc., may be used for dusting wheat to destroy rust (Puccinia graminis). (French patent 702,703.)

92. DISULPHIDE, 4-PHENYL-5-THIO-DELTA<sup>2</sup>-1,3,4-THIODIAZOLINE-2-,



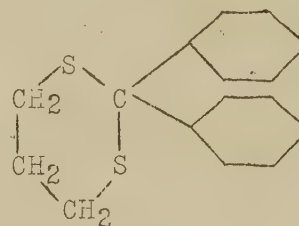
Synonyms: phenyl dithiodiazolone disulphide

A concentration of 1:260,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

93. DISULPHIDES.

Organic disulphides possess the property of preventing soil nematode (*Heterodera schachtii*) larvae from slipping out of the cysts until such time as the sugar beets have become strong enough to withstand their attack. These compounds may be placed in the soil in aqueous solution or emulsion or in admixture with an indifferent medium such as kieselguhr or earth. (British patent specification 249,830.)

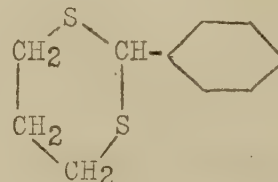
94. 1,3-DITHIANE, 2,2-DIPHENYL,



Synonym: 2,2-Diphenyl-tetramethylene-1,3-disulphide

A concentration of 1:10,000 in water killed 10 percent of culicine mosquito larvae in 9 hours. (Campbell et al., 1.)

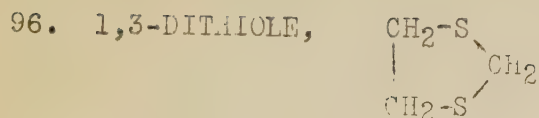
95. 1,3-DITHIANE, 2-PHENYL



Synonym: 2,2-Diphenyl-tetramethylene-1,3-disulfide

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 25 out of 50 larvae in 114 minutes, and 46 out of 50 in 8 hours. In another test 1:40,000 killed 25 out of 50 larvae in 58 minutes and the clear filtrate from the same solution killed 25 out of 50 in 162 minutes. A concentration of 1:100,000 killed 5 out of 50 larvae in 8 hours, and 6 in 20 hours. 1:200,000 killed 1 out of 50 in 8 hours and 3 in 20 hours. (Campbell et al., 1.)





Synonym: Trimethylene-1,3-disulphide

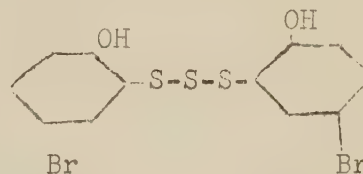
A concentration of 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., l.)

#### POLYSULPHIDES

#### 97. POLYSULPHIDES, BIS-HYDROXYARYL-,

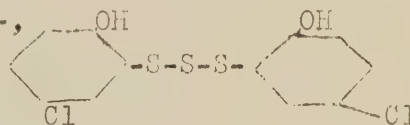
As aryl residues may be specified phenyl, naphthyl and like residues, and in addition to the two hydroxyl groups, the compounds may contain further substituents such as halogen, alkyl, aralkyl, aryl or additional hydroxyl groups, or nitro, amino or alkoxy groups. These compounds afford disinfecting or sterilizing preparations when diluted with a solid, semi-solid or liquid diluent, carrier or filler. (British patent 349,004.)

#### 98. TRISULPHIDE, BIS(5-BROMO-2-HYDROXYPHENYL)-,



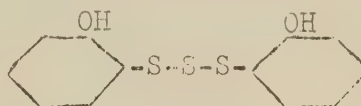
The sodium salt of this compound dissolved in water at 1:33,000 arrests the growth of coli bacteria and at 1:100,000 that of staphylococci. (British patent 349,004.)

#### 99. TRISULPHIDE, BIS(5-CHLORO-2-HYDROXYPHENYL)-,



A mixture of 3 parts of this compound and 97 parts of inert powder is suitable for combating mildew on plants. (British patent 349,004.)

#### 100. TRISULPHIDE, BIS-(2-HYDROXYPHENYL)-,

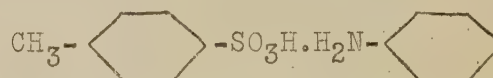


Ten parts by weight of the potassium salt of bis-(2-hydroxyphenyl)-trisulphide are mixed with an equal quantity of potassium soap and diluted with 10 times the quantity of water. A 2 percent solution of this mixture is very suitable for combating animal pests. (British patent 349,004.)

OXYGENATED SULPHUR COMPOUNDS

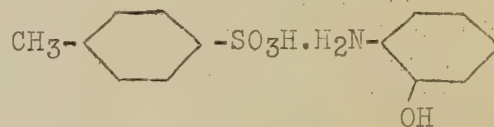
Sulphonic acids, sulphochlorides, sulphones, sulfoxides, sulphites, sulphates, etc.

101. ANILINE p-TOLUENE SULPHONATE,



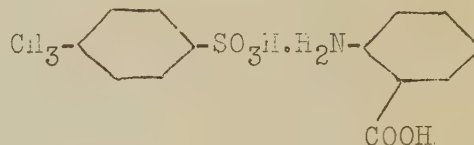
A concentration of 1:10,000 in water killed 2 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

102. ANILINE, o-HYDROXY, p-TOLUENE SULPHONATE



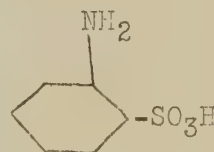
A concentration of 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

103. ANTHRANILIC ACID-p-TOLUENE SULPHONATE,



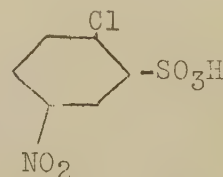
A concentration of 1:10,000 in water killed 2 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

104. BENZENESULPHONIC ACID, o-AMINO-



A concentration of 1:10,000 in water killed 6 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

105. BENZENESULPHONIC ACID, 2-CHLORO-5-NITRO



A concentration of 1:10,000 in water killed 4 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)



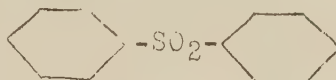
106. n-BUTANESULPHONYLCHLORIDE.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{SO}_2\text{Cl}$

Synonyms: Butan-sulfonsäure-(1) chlorid; Butan-alpha-sulfonsäure chlorid

B.p.  $96^\circ$

The maximum concentration, 600 mg./liter, tested as a fumigant against rice weevils (Sitophilus oryza L.) in wheat killed none of the insects in 24 hours. (Roark and Cotton, 18, p. 33.)

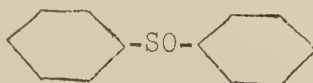
107. DIPHENYL SULPHONE



M.p.  $129^\circ \text{C}$ .

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 20 out of 50 larvae in 8 hours and 25 in 20 hours. (Campbell et al., 1.)

108. DIPHENYL SULPHOXIDE



M.p.  $70.5^\circ \text{C}$ .

A concentration of 1:10,000 in water killed 98 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

109. ETHANESULPHONIC ACID, AMINO, MONTANIC ACID DERIVATIVE



Twenty-five hundredths percent of the reaction product of montanic acid chloride and sodium aminoethanesulphonate can be added to calcium arsenate-, lead arsenate - or copper - containing spray materials for plants.

This montanic acid derivative can be used admixed with rosin oils or hydrocarbons and/or with fungicidal or insecticidal agents.

Control of Peronospora and Fusicladium with the copper sprays is mentioned. (German patent 550,961.)

110. ETHYL SULPHITE.  $(\text{CH}_3\text{CH}_2)_2\text{SO}_3$

Synonyms: diethyl sulphite; Diäthylsulfit; Diäthylester der Schwefligen Säure

B.p.  $161.3^\circ \text{C}$ .

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 108 mg./liter. (Roark and Cotton, 18, p. 34.)

111. ISETHIONIC ACID, MONTANIC ACID ESTER.  $C_{28}H_{57}COOC_2H_4SO_3H$

Synonyms: Ester aus Montansäurechlorid und Oxäthansulfosäure;  
2-hydroxy-ethanesulphonic acid, montanic acid ester

One kg. of copper sulphate and 300 g. of the ester from montanic acid chloride and hydroxyethanesulphonic acid are dissolved in 50 l. of water and then treated in the usual way with 50 l. of milk of lime. The 1 percent Bordeaux mixture thus prepared is used to combat Peronospora and Fusicladium. (German patent 550,961.)

112. METHYL SULPHATE.  $(CH_3)_2SO_4$

Synonym: Dimethylsulphate

B.p. 188.8° C.

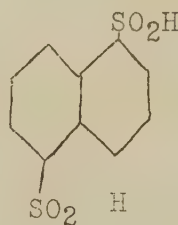
The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 667 mg./liter. (Roark and Cotton, 18, p. 34.)

Methyl sulphate showed value as an auxiliary gas with HCN in fumigation tests against ladybird beetles (Hippodamia convergens Guerin). Pratt et al., 15.)

113. MONTANIC ACID ESTERS OF SULPHONATED COMPOUNDS.

Derivatives of montanic acid with compounds of the type  $XRSO_3H$ , in which X represents an OH, SH, amino or imino group and R represents a  $(CH_2)_x$  chain, a phenyl residue or a similar, condensed aryl residue, are employed as plant protecting agents when admixed with resin oils or hydrocarbons and/or with fungicidal or insecticidal materials. (German patent 550,961.)

114. 1,5-NAPHTHALENEDISULPHINIC ACID.



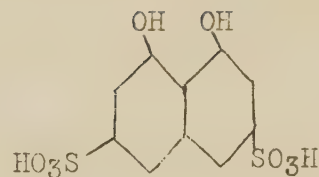
A concentration of 1:10,000 in water killed 20 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

115. 2,6-NAPHTHALENEDISULPHINIC ACID.



A concentration of 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

116. 3,6-NAPHTHALENEDISULPHONIC ACID, 1,8-DIHYDROXY.



A concentration of 1:10,000 in water killed 2 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

117. 2,6-NAPHTHALENE-DISULPHONYL CHLORIDE.



Synonym: naphthalene 2,6-disulphochloride

A concentration of less than 1:20,000 in water killed 6 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

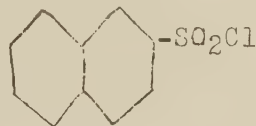
118. 2,7-NAPHTHALENE-DISULPHONYL-CHLORIDE.



Synonym: naphthalene-2,7-disulphochloride

A concentration of less than 1:40,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

119. 2-NAPHTHALENESULPHONYLCHLORIDE.



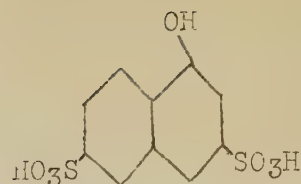
Synonym: Beta-naphthalene sulphochloride

M.p. 76° C.

Five tenths percent of beta-naphthalenesulphochloride intimately mixed with soil which was infested with Japanese beetle larvae was effective in killing the insects within 2 weeks. (Fleming, 4, pp. 816-817.)

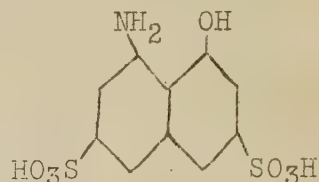


120. 1-NAPHTHOL-3,6-DISULPHONIC ACID.



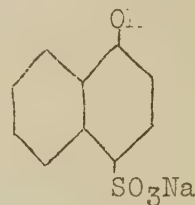
Tests as a contact insecticide for Aphis rumicis showed that the minimum toxic concentration (killing about 95 percent) was in excess of 1 gm. per 100 cc. (Richardson and Smith, 16, p. 6.)

121. 1-NAPHTHOL-3,6-DISULPHONIC ACID, 8-AMINO-



Tests as a contact insecticide for Aphis rumicis showed that the minimum toxic concentration (killing about 95 percent) was in excess of 1 gm. per 100 cc. (Richardson and Smith, 16, p. 8.)

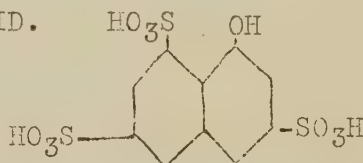
122. 1-NAPHTHOL-4-SULPHONIC ACID, SODIUM SALT



Synonym: Neville and Winther's acid, sodium salt

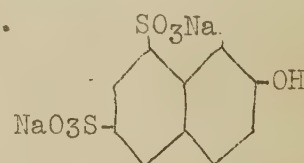
Thirty-three hundredths percent of sodium-1-naphthol-4-sulphonate intimately mixed with soil which was infested with Japanese beetle larvae was effective in killing the insects within 3 weeks. (Fleming, 4, pp. 816-817.)

123. 1-NAPHTHOL-3,6,8-TRISULPHONIC ACID.



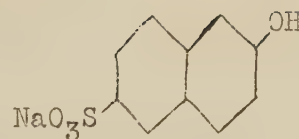
Tests as a contact insecticide for Aphis rumicis showed that the minimum toxic concentration (killing about 95 percent) was in excess of 1 gm. per 100 cc. (Richardson and Smith, 16, p. 6.)

124. 2-NAPHTHOL-6,8-DISULPHONIC ACID, SODIUM SALT.



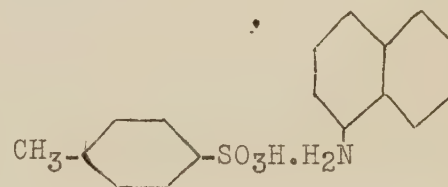
Tests as a contact insecticide for Aphis rumicis showed that the minimum toxic concentration (killing about 95 percent) was in excess of 1 gm. per 100 cc. (Richardson and Smith, 16, p. 6.)

125. 2-NAPHTHOL-6-SULPHONIC ACID, SODIUM SALT.



Tests as a contact insecticide for Aphis rumicis showed that the minimum toxic concentration (killing about 95 percent) was in excess of 1 gm. per 100 cc. (Richardson and Smith, 16, p. 6.)

126. ALPHA-NAPHTHOLAMINE p-TOLUENE SULPHONATE.



A concentration of 1:10,000 in water killed 34 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

127. PHENOLSULPHONIC ACID, SODIUM SALT.  $C_6H_4ONSO_3Na$

Tests as a contact insecticide for Aphis rumicis showed that the minimum toxic concentration (killing about 95 percent) was a saturated solution (20 + gm. per 100 cc.). Nasturtium plants tolerate 8 to 10 gm. per 100 cc.) (Richardson and Smith, 16, p. 6.)

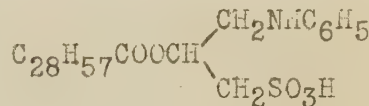
128. 1-PROPANESULPHONIC ACID, 3-HYDROXY, MONTANIC ACID ESTER.  
 $C_{28}H_{57}COOCH_2(CH_2)_2SO_3H$

Synonym: Montansäureester des 1-oxy-propan-3-sulfosäure

Two-tenths percent of the montanic acid ester of sodium 1-hydroxy-propane-3-sulphonate can be added to copper-containing spray materials for plants. Control of Peronospora and Fusicladium is mentioned.

This montanic acid derivative can be used admixed with rosin oils or hydrocarbons and/or with fungicidal or insecticidal agents. (German patent 550,961.)

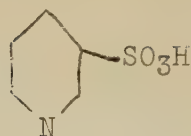
129. 1-PROPANESULPHONIC ACID, 2-HYDROXY-3-PHENYLIMINO, MONTANIC ACID ESTER.



Synonym: Montansäureester der 2-oxy-1-phenyliminopropan-3-sulfosäure

Two-tenths to five-tenths percent of the montanic acid ester of 2-hydroxy-1-phenyliminopropane-3-sulphonic acid is used in spray materials for pest control. This compound can be used admixed with rosin oils or hydrocarbons and/or with fungicidal or insecticidal agents. (German patent 550,961.)

130. PYRIDINE-BETA-SULPHONIC ACID.



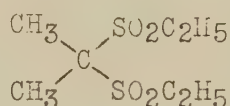
A solution of 4.9 g. per 100 cc. of pyridine beta-sulphonic acid containing 0.3 percent sodium fish oil as a spreader failed to kill as many as 95 percent of *Aphis rumicis* on nasturtium. This concentration was not tolerated by the nasturtium plants. (Richardson and Smith, 17, p. 608.)

131. SULPHANILIC ACID, p-TOLUENE SULPHONATE.



A concentration of 1:10,000 in water killed 4 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

132. SULPHOMAL.



M.p. 128° C.

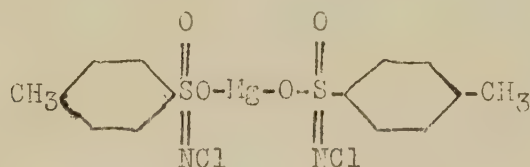
A concentration of 1:10,000 in water killed 6 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

133. SULPHOXIDE, BIS(BETA-CHLOROETHYL).  $C_4H_8Cl_2SO$

Synonym: dichlorodiethyl sulphoxide

Dichlorodiethyl sulphoxide caused serious burning when dusted on bean foliage. (Moore and Campbell, 10.)

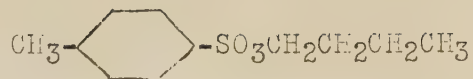
134. p-TOLUENESULPHONECHLORIMIDE, MAGNESIUM SALT.



A badly infected patch of ground was planted with potatoes and at harvest only 30 percent sound tubers were obtained and 70 percent diseased. They were very scabby. An equally badly infected patch was well dusted with magnesium p-toluene sulphonechloramide and the salt well worked in. Potatoes planted here gave only sound tubers at harvest. (German patent 514,045.)



135. p-TOLUENESULPHONIC ACID, n-BUTYL ESTER,



This compound either alone or admixed with HCN and applied as a fumigant to red scale (Chrysomphalus aurantii Mask.) on lemons showed little or no toxicity. (Cupples et al., 2.)

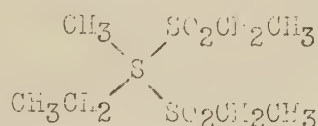
136. p-TOLUENESULPHONYL CHLORIDE.



B.p. 145-146° C. at 15 mm.

A dosage of 0.8 lb./1000 cu. ft. killed 100 percent of Plodia larvae in glass flasks but was ineffective against S. oryza, S. granarius and Tribolium. (Neifert et al., 13.)

137. TRIONAL.



M.p. 76° C.

A concentration of 1:10,000 in water killed 8 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

138. TURKEY RED OIL.

Synonym: sulphonated castor oil

Turkey red oil is used to increase the floatability on water of Paris green for killing Anophelino larvae. The mixture recommended is 10 lbs. Paris green, 1.5 oz. Turkey red oil and 4 gals. water. The Paris green is agitated with the water and Turkey red oil, filtered and dried. Untreated Paris green dusted on water effected practically no killing of larvae but after treatment with Turkey red oil it caused 100 percent mortality in a short time and kept the dusted area free of larvae for five days. (U. S. patent 1,942,532.)

#### SULPHONAMIDES

139. SULPHONAMIDES, HALOGENATED.

Halogenated sulphone amides are useful in combating potato scab. (German patent 514,045.)

#### THIAZOLE DERIVATIVES

140. BENZOTHAIAZOLE,1-AMINO-,



Synonym: 2-aminobenzothiazole

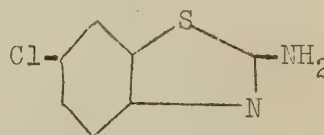
This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

Excellent control of Fomes annosus, a fungus living on wood, has been obtained by applying aqueous solutions of aminobenzothiazole and its substitution products and salts in concentrations of 0.1 down to 0.01 percent to cultures of this fungus. (Australian patent 8210/32, British patent 407,691, U. S. patent 1,962,109.)

2-Aminobenzothiazole and its substitution products in aqueous solution (0.5 to 0.1 percent plus a few percent of spreader) gave a control of over 90 percent on black chrysanthemum aphid and celery aphid. (Australian patent 8210/32, British patent 407,691.)

Aqueous solutions of from 1/2 to 1/10 percent of amino-benzo-thiazole, including its various substitution products, to which a few percent of a spreader, such as fish oil soap or a sulphonated mineral oil, was added, gave a control of over 90 percent on black chrysanthemum aphid and celery aphid. (U. S. patent 1,961,840.)

141. BENZOTHAIAZOLE, 1-AMINO-5-CHLORO-,



This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

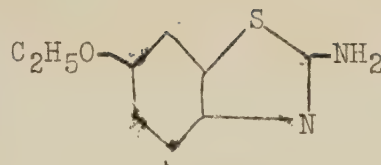
Sclerotinia cinerea, a parasite causing rot in stone fruit, was successfully controlled by aqueous solutions of 0.1 percent and less of 5-chloro-1-aminobenzothiazole. This agent also gave perfect control of Phoma pomi and Glomerella cingulata.

On Botrytis cinerea, which causes lettuce drop, applications of aqueous solutions of 0.1 down to 0.01 percent of the hydrochloride of 5-chloro-1-aminobenzothiazole have produced complete control. (Australian patent 8210/32; British patent 407,691.)

Applications of from 0.1 down to 0.01 percent aqueous solutions of the hydrochloride of 5-chloro-1-aminobenzothiazole have produced complete control of Botrytis cinerea, which causes lettuce drop.

Aqueous solutions of 0.1 percent and less of 5 chloro-1-aminobenzothiazole successfully controlled Sclerotinia cinerea, a parasite causing rot in stone fruit. Perfect control has also been obtained on Phoma pomi, the cause of Brock's spot on apples, which resists sulphur, and on Glomerella cingulata. (U. S. patent 1,962,109.)

142. BENZOTHAIAZOLE, 1-AMINO-5-ETHOXY-,



Synonym: 6-ethoxy-2-amino-benzothiazole

This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.

Sclerotinia cinerea, a parasite causing rot in stone fruit, was successfully controlled by aqueous solutions of 0.1 percent and less of 5-ethoxy-1-aminobenzothiazole hydrochloride. The same agent gave perfect control of Phoma pomi and Glomerella cingulata. Germination has been completely suppressed when 0.1 percent aqueous solutions of 5-ethoxy-1-aminobenzothiazole hydrochloride were applied to cultures of Verticillium albo-atrum, a fungus found on maple, elm, tomatoes, etc., Phomopsis, the cause of twig blight on elm trees, Graphium ulmi, the cause of the Dutch elm disease, Thielavia basicola, a tobacco fungus, and Fusarium moniliforme, a parasite of wheat and corn. On Botrytis cinerea, which causes lettuce drop, applications of aqueous solutions of 0.1 down to 0.01 percent of 5-ethoxy-1-aminobenzothiazole hydrochloride produced complete control. (Australian patent 8210/32; British patent 407,691; U. S. patent 1,962,109.)

Among the most effective aphicides was an aqueous solution of 0.5 percent of 6-ethoxy-2-aminobenzothiazole hydrochloride with 0.5 percent of sulphonated mineral oil, which gave a 100 percent kill of aphids. (Australian patent 8210/32; British patent 407,691.)

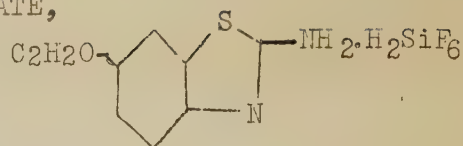
An aqueous solution of 1/2 percent of 5-ethoxy-1-aminobenzothiazole hydrochloride with 1/2 percent of sulphonated mineral oil gave a 100 percent kill of black chrysanthemum aphid and celery aphid. (U. S. patent 1,961,840.)

Sclerotinia cinerea on stone fruit was successfully controlled by aqueous solutions of 0.1 percent and less of 5-ethoxy-1-aminobenzothiazole, which also gave perfect control of Phoma pomi, the cause of Brock's spot on apples, which resists sulphur, and of Glomerella cingulata. Complete control of Botrytis cinerea which causes lettuce drop was obtained with aqueous solutions of from 0.10 to 0.01 percent 5-ethoxy-1-amino-benzothiazole hydrochloride.

Germination has been completely suppressed when 0.1 percent aqueous solutions of 5-ethoxy-1-amino-thiazole hydrochloride were applied to cultures of Verticillium albo-atrum, a fungus found on maple, elm, tomatoes, etc.; Phomopsis, the cause of twig blight on elm trees, Graphium ulmi, the cause of the Dutch elm disease, Thielavia basicola, a tobacco fungus, and Fusarium moniliforme, a parasite of wheat and corn which is resistant to most fungicides. (U. S. patent 1,962,109.)



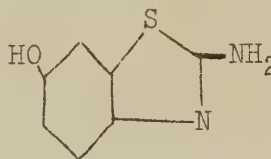
143. BENZOTHAZOLE, 1-AMINO-5-ETHOXY, FLUOSILICATE,



Synonym: 5-ethoxy-1-aminobenzothiazole fluosilicate

A 0.25 percent aqueous solution of 6-ethoxy-2-amino-benzothiazole fluosilicate with 0.5 percent fish oil soap, used as a spray on the black chrysanthemum aphids, killed over 99 percent of the aphids without plant injury. Sulphonated oxidized petroleum oil may be used as a spreader in place of fish oil soap. (British patent 396,064.)

144. BENZOTHAZOLE, 1-AMINO-5-HYDROXY-,

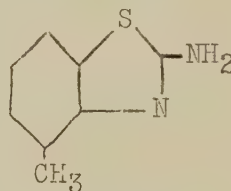


This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 8210/32; British patent 407,691.)

This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.) This compound is a contact insecticide. (U. S. patent 1,961,840.)

This compound is toxic toward micro-organisms. (U. S. patent 1,962,109.)

145. BENZOTHAZOLE, 1-AMINO-3-METHYL-,



M.p. 126.5°

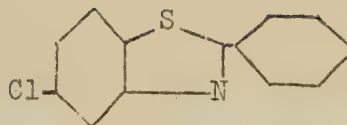
This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 8210/32; British patent 407,691.)

Specific toxicity to insects is claimed. This is classed as a contact insecticide. (U. S. patent 1,961,840.)

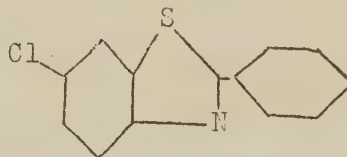
This compound possesses toxicity toward micro-organisms. (U. S. patent 1,962,109.)

146. BENZOTHAIAZOLE, 4-CHLORO-1-PHENYL,



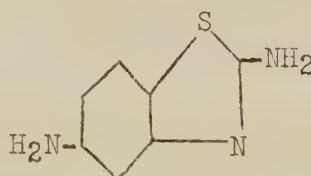
A concentration of 1:10,000 in water killed 76 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

147. BENZOTHAIAZOLE, 5-CHLORO-1-PHENYL,



A concentration of 1:10,000 in water killed 88 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

148. BENZOTHAIAZOLE, 1,4-DIAMINO-,



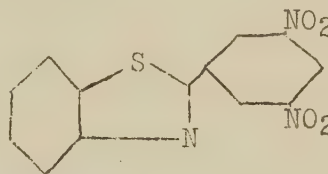
This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 3210/32; British patent 407,691.)

This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

This compound is toxic toward micro-organisms. (U. S. patent 1,962,109.)

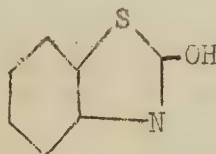
This compound is a contact insecticide. (U. S. patent 1,961,840.)

149. BENZOTHAIAZOLE, 1-(3',5'-DINITROPHENYL)-,



A concentration of 1:10,000 in water killed 4 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

150. BENZOTHAIAZOLE, 1-HYDROXY-,



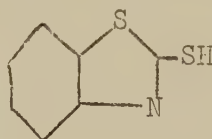
This compound possesses excellent insecticidal, fungicidal bactericidal and like properties. (Australian patent 3210/32; British patent 407,691.)

This is a disinfectant for seeds, tubers, corms, etc. (British patent 407,708.)

Aqueous solutions of from 1/2 to 1/10 percent of hydroxybenzothiazoles, to which a spreader, such as fish oil soap or a sulphonated mineral oil, was added, gave a control of over 90 percent of black chrysanthemum aphid and celery aphid. (U. S. patent 1,961,840.)

This compound is toxic toward micro-organisms. (U. S. patent 1,962,109.)

151. BENZOTHAIAZOLE, 1-MERCAPTO-,



Excellent control of Fomes annosus, a fungus living on wood, has been obtained by applying aqueous solutions of mercaptobenzothiazole and its salts in concentrations of 0.1 down to 0.01 percent to cultures of this fungus.

Sclerotinia cinerea, a parasite causing rot in stone fruit, was successfully controlled by aqueous solutions of 0.1 percent and less of the sodium salt of mercaptobenzothiazole. Perfect control was obtained with the same agent on Phoma pomi and Glomerella cingulata. (Australian patent 8210/32; British patent 407,691; U. S. patent 1,962,109.)

Aqueous solutions of the sodium salt of mercaptobenzothiazole gave complete control of Botrytis cinerea at concentrations of 0.10 down to .01 percent. (Australian patent 8210/32; British patent 407,691; U. S. patent 1,962,109.)

Aqueous solutions of from 1/2 to 1/10 percent of mercaptobenzothiazole and its sodium salt, to which a few percent of a spreader, such as fish oil soap or a sulphonated mineral oil, was added, gave control of over 90 percent on black chrysanthemum aphid and celery aphid. An aqueous solution of 1/3 percent sodium mercaptobenzothiazole, with 1/2 percent fish oil soap, gave a 100 percent kill of the aphids. (Australian patent 8210/32; British patent 407,691; U. S. patent 1,961,840.)

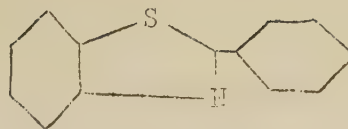
This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

A concentration of 1:10,000 in water killed 88 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

Aqueous solutions of mercaptobenzothiazole and its salts in concentrations of from 0.10 to 0.01 percent give excellent control of Fomes annosus in cultures. The sodium salt of mercaptobenzothiazole in aqueous solution gave excellent control of Sclerotinia cinerea on stone fruit; Phoma pomi (which causes Brock's spot on apples); Glomerella cingulata; and Botrytis cinerea which causes lettuce drop. (U. S. patent 1,962,109.)

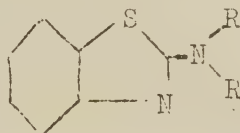


## 152. BENZOTHIAZOLE, 1-PHENYL-,

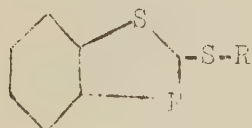


A concentration of 1:10,000 in water killed 68 percent of culicine mosquito larvae in 18 to 24 hours. 1:40,000 killed 25 out of 50 larvae in 330 minutes, 20 out of 50 in 3 hours, and 36 out of 50 in 20 hours. In another test 1:40,000 killed 25 out of 50 larvae in 81 minutes, and the clear filtrate from the same solution killed 25 out of 50 in 82 minutes. 1:100,000 killed 25 out of 50 larvae in 60 minutes and 1:200,000 did so in 213 minutes. The compound was ineffective as compared to rotenone against Musca domestica, and ineffective as compared to lead arsenate against Bombyx mori, Prodenia eridania, and Ascia rapis. (Campbell et al., 1.)

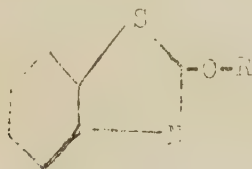
## 153. BENZOTHIAZOLES.



A benzothiazole of this formula where R is hydrogen, a hydrocarbon or an acyl radical is classed as a contact insecticide. (U. S. patent 1,961,840.)

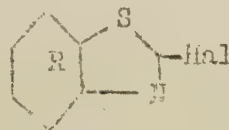


A benzothiazole of this formula where R is hydrogen or an atom or atom grouping which can replace hydrogen when it exercises its acidic functions is also classed as a contact insecticide. (U. S. patent 1,961,840.)



A benzothiazole of this formula where R is hydrogen or an atom or atom grouping which can replace hydrogen when it exercises its acidic functions is stated to be insecticidal against aphids, house flies, clothes moth larvae and other harmful insects. (U. S. patent 1,961,840.)

## 154. BENZOTHIAZOLES, 1-HALOGENOARYL



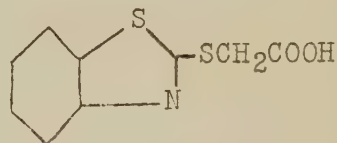
Synonyms: 2-halogen-aryl-thiazoles

1-Halogen-aryl-thiazoles of the above formula, where R is an aromatic ring substituted by any substituent and "Hal" is chlorine or bromine, can be reacted to exchange the halogen with any desired compound possessing a mobile hydrogen attached to, e. g., a nitrogen, oxygen, sulphur or carbon atom. The substances obtained are intended to find application in combating insects. (U.S. patent 1,373,099; British patent 310,315.)

155. BENZOTHAZOLES, HYDROXY-,

Aqueous solutions of from 0.5 to 0.1 percent of hydroxybenzothiazoles, with a few percent of a spreader, were found to give a control of over 90 percent on black chrysanthemum aphid and celery aphid. (Australian patent 8210/32; U. S. patent 1,962,109.)

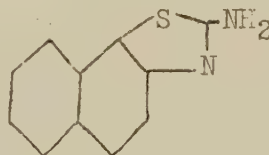
156. GLYCOLIC ACID, THIO, 1-BENZOTHAZOLE,



This compound is toxic toward micro-organisms. (U. S. patent 1,962,109)

This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 8210/32.) This compound is a contact insecticide. (U. S. patent 1,961,840.)

157. 1,2-NAPHTHIAZOLE, 1-AMINO-,



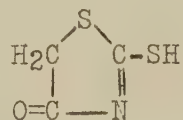
This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 8210/32; British patent 407,691)

Aqueous solutions of from 1/2 to 1/10 percent of naphthothiazoles, to which a few percent of a spreader, such as fish oil soap or a sulphonated mineral oil, was added, gave a control of over 90 percent on black chrysanthemum aphid and celery aphid. (Australian patent 8210/32; U. S. patent 1,961,840)

This compound is toxic toward micro-organisms. (U. S. patent 1,962,109)

158. RHODANINE,



Synonyms: 2-thio-2,4-thiazolidione, 4-keto-2-thiothiazolidine, 3-keto-1-thiocarbonyltetrahydrothiazole, 3-keto-1-thiocarbonyltetrahydrothiazole, rhodanic acid, Rhodaninsäure, 3-keto-1-thiothiazolidine

M.p. 168-170° C.

This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 8210/32; British patent 407,691.)

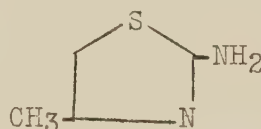
This compound is toxic toward micro-organisms. (U. S. patent 1,962,109.)

This compound is a contact insecticide. (U. S. patent 1,961,840.)

#### 159. THIAZINE DERIVATIVES.

Products suitable for combating cryptogamic, bacterial or nematode diseases of plants, grains or the like or for sterilizing infected soils are obtained by mixing an organic coloring matter soluble in water with a substituted amide of a fatty acid. Among dyes mentioned are thiazine derivatives. Amides mentioned are dimethyl-oleyl-amido-ethyl-amine, stearyl-amido-ethylamine, diethyl-linoleyl-amido-ethylamine, dimethyl-stearyl-amido-ethylamine, palmityl-amido-propylamine, oleyl-amido-ethylamine, and the addition product of dimethyl sulphate and diethyl-oleyl-amido-ethyl-amine. The amides may be used in the form of their salts, e. g. hydrochlorides, oxalates, tartrates, benzoates, or salicylates. (British patent 364,046.)

#### 160. THIAZOLE, 2-AMINO-4-METHYL-



Synonyms: 3-methyl-1-aminothiazole; sulfocyanpropimin

M.p. 42°

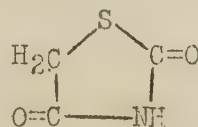
This is a contact insecticide. (U. S. patent 1,961,840.)

This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 8210/32; British patent 407,691.)

This compound is toxic toward micro-organisms. (U. S. patent 1,962,109.)

#### 161. THIAZOLE, 2,4-DIKETO-TETRAHYDRO-



Synonym: 2,4-thiazoledione

This compound is toxic toward micro-organisms. (U. S. patent 1,962,109)

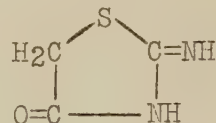
This compound is a contact insecticide. (U. S. patent 1,961,840.)



This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

This compound possesses excellent insecticidal, fungicidal, bactericidal and the like properties. (Australian patent 8210/32; British patent 407,691.)

162. THIAZOLE, 2-IMINO-4-KETO-TETRAHYDRO-



Synonyms: 1-imino-3-thiazolidone; Pseudothiohydantoin; 2-imino-4-thiazolidone

This compound possesses excellent insecticidal, fungicidal, bactericidal and like properties. (Australian patent 8210/32; British patent 407,691.)

This is a disinfectant for seeds, corms, tubers, etc. (British patent 407,708.)

A contact insecticide. (U. S. patent 1,961,840.)

This compound is toxic toward micro-organisms. (U. S. patent 1,962,109)

163. THIAZOLES.

Thiazole derivatives carrying a salt forming group, and their salts, esters, ethers and anhydrides possess fungicidal and bactericidal properties. The salt forming groups, which are attached to one of the carbon atoms of the five-membered nucleus, may be acidic or basic. Acid groups are: -SH, -OH, -SCH<sub>2</sub>COOH and other carboxylic, etc., groups. Basic groups may be -NH<sub>2</sub> and its substitution products, such as alkyl, aryl, acyl, etc. These fungicides and bactericides are used as a rule in aqueous solution or suspension containing less than 1 percent of the active ingredients. From 1/4 to 1/2 percent of a spreader, such as a fish oil soap or a sulphonated mineral oil, is added. (Australian patent 8210/32; British patent 407,691; U. S. patent 1,962,109.)

Wetting agents or spreaders, such as sulphonated oils, gums, gelatinous materials, soaps, caseinates, etc., may be added. Thiazole derivatives with dyeing properties are excluded. (British patent 407,708.)

Products suitable for combating cryptogamic, bacterial or nematode diseases of plants, grains or the like or for sterilizing infected soils are obtained by mixing an organic coloring matter soluble in water with a substituted amide of a fatty acid. Among dyes mentioned are thiazole derivatives. Amides mentioned are dimethyl-oleyl-amido-ethylamine, stearyl-amido-ethylamine, diethyl-linoleyl-amido-ethylamine, dimethyl-stearyl-amido-ethylamine, palmityl-amido-propylamine, oleyl-amido-ethylamine, and the addition product of dimethyl sulphate and diethyl-oleyl-amido-ethylamine. The amides may be used in the form of their salts, e. g. hydrochlorides, oleates, oxalates, tartrates, benzoates, or salicylates. (British patent 364,046.)

A thiazole of the formula 
$$\begin{array}{c} | \\ -C-N \\ | \quad \diagup \\ -C-S \quad C-X \\ | \end{array}$$
 where X is a salt-forming

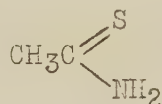
group such as SH, OH, SCH<sub>2</sub>COOH, SO<sub>3</sub>H, SCSH, etc., or a basic group such as NH<sub>2</sub> is classed as a contact insecticide. (U. S. patent 1,961,840.)

A thiazole of the formula 
$$\begin{array}{c} | \\ -C-N \\ | \quad \diagup \\ -C-S \quad C-X-R \\ | \end{array}$$
 where X is one of the

elements N, O and S and R is hydrogen or an atom or atom grouping which can replace hydrogen when it exercises its acidic functions is classed as a contact insecticide. (U. S. patent 1,961,840.)

#### THIOACIDS AND DERIVATIVES

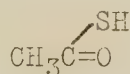
164. ACETAMIDE, THIO-



M.p. 107.5-108.5° C.

A concentration of 1:10,000 in water killed 20 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

165. ACETIC ACID, THIO-



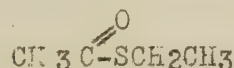
Synonyms: Thioessigsäure; Thiacetsäure, Äthanthiolsäure

B.p. 93°

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 215 mg./liter. (Roark and Cotton, 18, p. 33.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

166. ACETIC ACID, THIO-, ETHYL ESTER

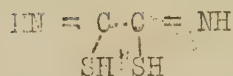


Synonyms: ethyl thioacetate; Thioessigsäuresäthylester

B.p. 116° C.

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

167. OXALAMIDE, DITHIO-

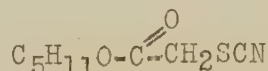


Synonym: Rubeanwasserstoffsäure

A concentration of 1:10,000 in water killed 20 percent of culicine mosquito larvae in 9 hours. (Campbell et al., 1.)

#### THIOCYANATES

168. ACETIC ACID, THIOCYANO-, AMYL ESTER,



Amyl thiocyanacetate possesses insecticidal properties. (German patent 562,672.)

Amyl thiocyanacetate can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,983; British patent 361,900; French patent 696,326.)

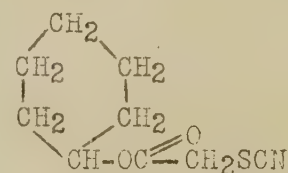
169. ACETIC ACID, THIOCYANO-, 2-(2'-BUTOXYETHOXY) ETHYL ESTER,



Synonym: ~~beta~~-thiocyanoacetate of diethylene glycol monobutyl ether

An aqueous spray containing 0.1 percent of the beta-thiocyanoacetate of diethylene glycol monobutyl ether and 0.5 percent of Penetrol killed 92.9 and 93.4 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 43.3 and 42.6 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 273.)

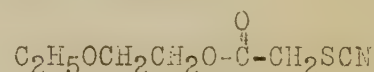
170. ACETIC ACID, THIOCYANO-, CYCLOHEXYL ESTER,



Cyclohexyl thiocyanacetate can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

Cyclohexylthiocyanacetate possesses insecticidal properties. (German patent 562,672.)

171. ACETIC ACID, THIOCYANO-, BETA-ETHOXYETHYL ESTER,

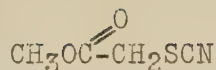


This compound can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

Beta-ethoxyethylthiocyanacetate possesses insecticidal properties. (German patent 562,672.)



172. ACETIC ACID, THIOCYANO-, METHYL ESTER,

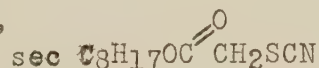


B.p. 120-122° C.

If methylthiocyanacetate is vaporized in a closed room which contains insects, such as flies, mosquitoes and moths, the insects are killed in a short time. (German patent 562,672.)

An aqueous spray containing 0.1 percent of methyl thiocynoacetate and 0.5 percent of a spreader (Tanoyl) killed 66.0 and 54.7 percent of Aphis rumicis on nasturtium. The spreader alone killed 28.5 and 35.2 percent of the aphids. The methyl thiocynoacetate caused severe injury to nasturtium plants. (Hartzell and Wilcoxon, 5, pp. 271, 272.)

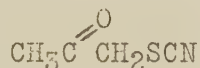
173. ACETIC ACID, THIOCYANO-, SEC.-OCTYL ESTER,



About 1 g. of the compound is dissolved in sufficient organic solvent, e. g., kerosene, to make the total volume 100 cc. If the resulting solution is sprayed in a room containing flies, the flies are practically completely eliminated within a very short period. (U. S. patent 1,808,893; British patent 361,900.)

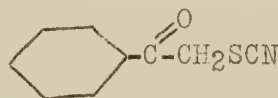
Sec-octylthiocyanacetate possesses insecticidal properties. (German patent 562,672.)

174. ACETONE: THIOCYANO-,



Thiocyano acetone can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900; French patent 396,326.)

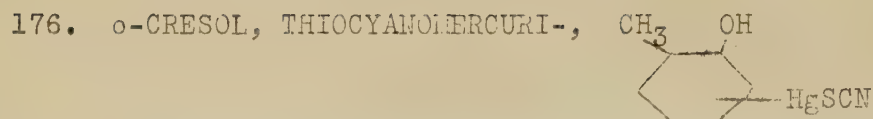
175. ACETOPHENONE, OMEGA-THIOCYANO-,



Synonyms: thiocyanomethylphenylketone; phenacyl thiocyanate.

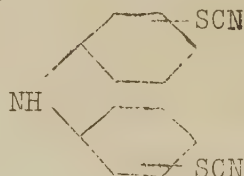
An aqueous spray containing 0.1 percent of thiocyanomethyl phenyl ketone and 0.5 percent of Penetrol killed 65.0 and 69.4 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 42.8 and 47.3 percent of the aphids. The thiocyanomethyl phenyl ketone formed a poor emulsion. (Hartzell and Wilcoxon, 5, pp. 271, 273.)

Omega-thiocyanoacetophenone possesses insecticidal properties. (German patent 562,672.)



Synonym: Rhodanmercuri-o-Kresol

Thiocyanomercuri-o-cresol possesses fungicidal and bactericidal action. (German patent 484,995.)



Synonym: diphenylamine dithiocyanate, Dirhodaniphenylamin

Diphenylamine dithiocyanate possesses insecticidal properties. (British patent 317,525.)

A mixture of 5 parts dithiocyanodiphenylamine and 95 parts talc forms a dusting mixture that suffices to kill in a very short time the larvae and imagines of Piesma quadrata. (U. S. patent 1,815,816; Dutch patent 21,982; French patent 654,416.)

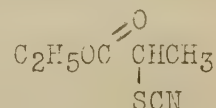


Synonym: Diethylthiocyanomalonate

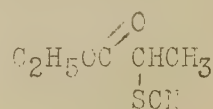
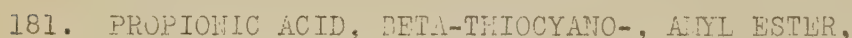
Diethylthiocyanomalonate possesses insecticidal properties. (German patent 562,672.)



Thiocyanomercuri phenols possess bactericidal, fungicidal and often pharmaceutical properties. (German patent 484,995.)



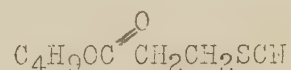
An aqueous spray containing 0.1 percent of ethyl alpha-thiocyanopropionate and 0.5 percent of spreader (Tanoyl) killed 29.3 and 38.8 percent of Aphis rumicis on nasturtium. (Hartzell and Wilcoxon, 5, p. 272.)



Amyl beta-thiocyanopropionate possesses insecticidal properties. (German patent 562,672.)

This compound can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

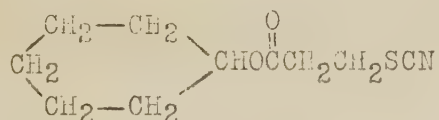
182. PROPIONIC ACID, BETA-THIOCYANO-, BUTYL ESTER,



Butyl beta-thiocyanopropionate possesses insecticidal properties. (German patent 562,672.)

This compound can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

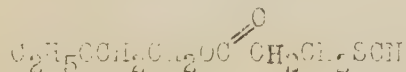
183. PROPIONIC ACID, BETA-THIOCYANO-, CYCLOHEXYL ESTER,



Cyclohexyl beta-thiocyanopropionate possesses insecticidal properties. (German patent 562,672.)

This compound can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

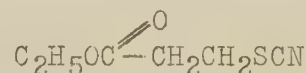
134. PROPIONIC ACID, BETA-THIOCYANO-, BETA-ETHOXYETHYL ESTER,



Beta-ethoxyethyl beta-thiocyanopropionate possesses insecticidal properties. (German patent 562,672.)

About 1 g. of the compound is dissolved in sufficient organic solvent, e. g., kerosene, to make the total volume 100 cc. If the resulting solution is sprayed in a room containing flies, the flies are practically completely eliminated within a very short period. (U. S. patent 1,808,893; British patent 361,900.)

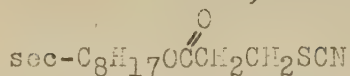
185. PROPIONIC ACID, BETA-THIOCYANO-, ETHYL ESTER,



In aqueous spray containing 0.1 percent of ethyl beta-thiocyanopropionate and 0.5 percent of a spreader (Tanoyl, a sulphonated fish oil) killed 50.3 and 60.8 percent of Aphis rumicis on nasturtium. The spreader alone killed 20.6 and 32.1 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 272.)



186. PROPIONIC ACID, BETA-THIOCYANO-, SEC.-OCTYL ESTER,



sec.-Octyl beta-thiocyanopropionate possesses insecticidal properties. (German patent 562,672.)

This compound can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900.)

187. SULPHIDES, THIOCYANO-.

Synonyms: thiocyno thioethers; Rhodanthioäther

Compounds containing both a thiocyanate and a thioether group display stronger or equal insecticidal activity as compared with those containing merely a thiocyanate group and are claimed for use as insecticides in German patent 506,085.

188. THIOCYANATES.

Synonyms: Rhodanwasserstoffsäureester; sulphocyanates

Various thiocyanates are highly toxic to red scale (Chrysomphalus aurantii Mask.) on lemons at moderate concentrations. They are less injurious than the isothiocyanates to citrus fruit and foliage. The following table shows the variation of toxicity with chemical structure:

Hydrogen cyanide	H-CN	Very toxic
Organic cyanides	R-CN	Very slightly toxic
Organic thiocyanates	R-SCN	Very toxic

(Cupples et al., 2.)

Thiocyanic esters and their derivatives such as nitro, amino, chloro, and alkyl derivatives, are active contact poisons and repellents for insects. They may be alkyl, aralkyl, aryl, heterocyclic, or polycyclic compounds. (German patent 520,330.)

The aromatic mono- or polythiocyanates and the aliphatic polythiocyanates or the derivatives or substitution products of these thiocyanates possess insecticidal properties. (British patent 317,525.)

Thiocyanic esters which contain in the molecule two or more carbon atoms each holding two thiocyanate groups are especially active insecticides. (German patent 548,091.)

Organic thiocyanates containing a negative or negatively bound radical in the organic residue possess insecticidal properties. These thiocyanates may contain carbonyl groups, aromatic rings, unsaturated groups, halogen groups, other thiocyanate groups, nitro-, hydroxyl-, alkoxy-, carbalkoxy-, or cyano groups, acidradicals, etc. (German patent 562,672.)

189. THIOCYANATES, ALIPHATIC,  $R-S-C\equiv N$ 

The application of 0.125 percent solution of an aliphatic thiocyanate containing 0.25 percent anhydrous soap gave an average kill of 97.2 percent of Pseudococcus citri Risso (mealy bug); containing 0.5 percent Penetrol, it gave a 96.3 percent kill; containing 0.1 percent Penetrol, the kill was 94.88 percent. The same concentration (0.125 percent) of the thiocyanate plus 0.25 or 0.50 percent Penetrol was sufficient to kill 90 percent of the eggs of the insect. (Murphy and Feet, 12.)

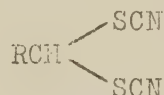
A 0.0625 percent solution of an aliphatic thiocyanate containing 0.25 percent anhydrous soap (potassium stearate) killed an average of 98.58 percent of Aphis rumicis L. and the same concentration of the thiocyanate containing 0.5 percent Penetrol killed 99.0 percent. Practical field tests gave still more satisfactory results. Especially good results (which will be reported later) have been obtained with mealy bug and red spider. The aliphatic thiocyanate used in these tests caused no foliage injury upon a wide variety of plants. (Murphy and Feet, 11.)

Aliphatic thiocyanates containing one or more negative elements in the organic radical possess the usual insecticidal properties of thiocyanates but are devoid of certain undesirable properties of other thiocyanates, e. g., offensive and persistent odor and irritant properties. Of these negative elements (such as O, S or I) or groups, oxygen is of especial value. The insecticidal properties of these compounds is so great that they can be satisfactorily employed in solutions or mixtures of considerable dilution. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

## 190. THIOCYANATES, AROMATIC.

Aromatic monothiocyanates, their derivatives and substitution products are extraordinarily active in destroying insects and are claimed as insecticides. (U. S. patent 1,794,406; Dutch patent 21,982, French patent 654,416.)

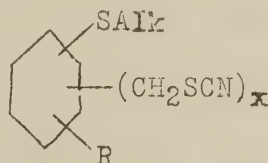
## 191. THIOCYANATES, DI-,



Synonym: Dirhodanide

Thiocyanates containing two thiocyanate groups attached to one carbon atom are more active insecticides than monothiocyanates or those with two thiocyanate groups on different carbons and do no harm to even very sensitive plants. They may be used as sprays in 1 to 5 percent dispersion with Turkey red oil and as dusting agents with powdered materials such as talc, ashes, or calcium arsenate containing powders. (German patent 545,740.)

## 192. THIOCYANATES, POLY-,



Here Alk stands for an alkyl radical, X for 1 or 2 and R for hydrogen, halogen or an alkyl radical. These compounds possess insecticidal properties. (U. S. patent 1,841,458.)

Aromatic thiocyanates containing one or more methoxy groups and more than one thiocyanate group are claimed as insecticides in British patent 325,910.

Organic polythiocyanates, their derivatives and substitution products are extraordinarily active insecticides. (U. S. patent 1,815,816; Dutch patent 21,982; French patent 654,416.)

Aromatic compounds containing more than one thiocyanate group are very active insecticides and mothproofing agents. They are odorless and harm neither plants nor the mucuous membranes of persons. They can be used in aqueous emulsions, in colloidal form as dusting powders or dissolved in organic solvents. (German patent 501,135.)

193. THIOCYANIC ACID, HSCN

Synonym: Rhodanwasserstoffsäure

M. p. 5° C.

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity either alone at concentrations of 1.8 and 3.0 mg. per liter of air for 25 minutes or as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

194. THIOCYANIC ACID, 2-(2'-ALKOXYETHOXY) ETHYL ESTERS, ROCH<sub>2</sub>CH<sub>2</sub>OCH<sub>2</sub>CH<sub>2</sub>SCN

Synonym: beta-thiocyano derivative of the mono-alkyl ethers of diethylene glycol.

The alkyl group may be any one of low molecular weight such as methyl, ethyl, propyl, butyl, etc. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

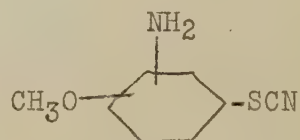
195. THIOCYANIC ACID, ALLYL ESTER, CH<sub>2</sub>=CHCH<sub>2</sub>SCN

Synonym: Allylrhodanid

B.p. 180-181° C.

Allyl thiocyanate is an active contact poison and repellent for insects. (German patent 520,330.)

196. THIOCYANIC ACID, AMINOANISYL ESTER,



Synonym: thiocyanoanisidine

Thiocyanoanisidine possesses insecticidal properties. (German patent 562,672.)



197. THIOCYANIC ACID, AMINONAPHTHYL ESTER,

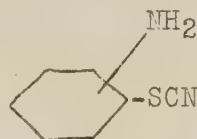


Thiocyanonaphthylamine possesses insecticidal properties. (German patent 562,672.)

198. THIOCYANIC ACID, BUTYLMERCURIC ESTER,  $C_4H_9HgSCN$

A mixture of 3 parts of butyl mercuric thiocyanate, 94 parts of calcium carbonate and 3 parts of diatomaceous earth is well adapted for dusting seeds to kill the spores of stinking smut. (U. S. patent 1,938,839.)

199. THIOCYANIC ACID, AMINOPHENYL ESTER,



Synonyms: thiocyananiline; Rhodananilin

Two and five-tenths parts of thiocyananiline and 2.5 parts of benzylthiocyanate are dissolved in 10 parts of alpha-chloronaphthalene and 5 parts of butyl alcohol. Sixty parts of an emulsifying agent are added, e. g., a solution of 50 percent strength of the sodium salt of dibutyl-naphthalene-sulphonic acid or a soap. The mixture is then diluted to 100 parts by water. A solution of 1-2 percent strength of this stock preparation yields an excellent spraying agent for exterminating bugs or lice.

A mixture of 5 parts of thiocyananiline and 95 parts of talc, mixed to form a dusting agent, suffices to kill in a very short time the larvae and imagines of Piesma quadrata. (U. S. patent 1,794,046; Dutch patent 21,982; French patent 654,416; British patent 317,525.)

200. THIOCYANIC ACID, p-AMINOPHENYL ESTER,

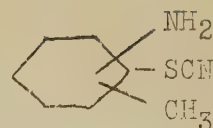


Synonym: p-thiocyananiline

p-Thiocyananiline possesses insecticidal properties. (German patent 562,672.)

An aqueous spray containing 0.1 percent of p-thiocyananiline and 0.5 percent of Penetrol killed 99.2 and 99.1 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 24.1 and 28.6 percent of the aphids. The p-thiocyananiline caused severe injury to the nasturtium plants. (Hartzell and Wilcoxon, 5, pp. 271, 273.)

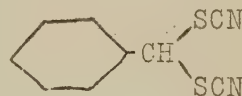
201. THIOCYANIC ACID, AMIOTOLYL ESTER,



Synonym: thiocyanotoluidine

Thiocyanotoluidine possesses insecticidal properties. (German patent 562,672.)

202. THIOCYANIC ACID, BENZAL ESTER,



Synonym: Benzalrhodanid

Benzalrhodanid is an active insecticide harmless to plants. (German patent 545,740.)

203. THIOCYANIC ACID, BENZYL ESTER,



Synonym: Benzylrhodanid

M.p. 41-3°

There was no apparent toxicity to goldfish at concentrations of  $3.36 \times 10^{-5}$ ,  $5.60 \times 10^{-5}$ , and  $7.38 \times 10^{-5}$  mole per liter. (Drake and Busbey, 3.)

A solution is made by stirring together, while heating, 144 parts of colophony, 68 parts of caustic soda lye (25 percent strength), 100 parts of alcohol, 82 parts of the first runnings of benzene distillation, 28 parts of water and 20 parts of benzyl thiocyanate. A 4 percent solution of this stock preparation constitutes a spraying agent for exterminating insects which winter in cellars or the like.

Two and five-tenths parts of aniline thiocyanate and 2.5 parts of benzylthiocyanate are dissolved in 10 parts of alpha-chloronaphthalene and 5 parts of butyl alcohol. Sixty parts of an emulsifying agent (e. g. a 50 percent solution of sodium dibutyl-naphthalenesulphonate or a soap) are added. The mixture is then diluted to 100 parts by water. A solution of 1 to 2 percent of this stock solution is a spraying agent for bugs and lice. (British patent 317,525; Dutch patent 21,982; French patent 654,416; U. S. patent 1,794,046.)

A mixture of 5 parts benzylthiocyanate and 95 parts talc used as a dusting agent suffices to kill in a very short time the larvae and imagines of Piesma quadrata.

Benzylthiocyanate in a 1 percent aqueous-acetone emulsion kills, at most, 80 percent of green plant lice, and even at this concentration burning of the leaves starts. (German patent 501,135.)

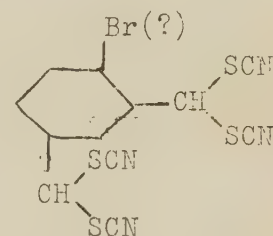
One-tenth percent benzylthiocyanate used as a spray killed all plant lice.

A mixture of 2 g. benzylthiocyanate, 5 cc. pyridine and 10 cc. Turkey red oil can be used as a 1 to 2 percent spray. A mixture of 2 parts benzylthiocyanate and 98 parts talc, dusted on plants, serves to protect against ground fleas, and, mixed with seeds, prevents their being eaten by birds. Ants can be permanently driven away from trees by treating the places most frequented by them with a 5 percent solution of benzylthiocyanate in carbon tetrachloride. (German patent 520,330.)

Benzyl thiocyanate dissolved in acetone to which a wetting agent soluble in acetone, e. g. isobutyl-naphthalenesulphonic acid, is added, and diluted with water to a concentration of 5:1,000 kills plant lice on green plants but the leaves begin to char. A 1 percent emulsion killed 70 percent of green plant lice on cucumber; 0.5, 1 and 2 percent emulsions killed 50 80 and 100 percent respectively of green plant lice on cenerarie. (British patent 325,910.)

An aqueous spray containing 0.1 percent of benzyl thiocyanate and 0.5 percent of Penetrol killed 91.7 and 81.6 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 20.0 and 26.9 percent of the aphids. The benzyl thiocyanate formed a poor emulsion. (Hartzell and Wilcoxon, 5, pp. 271, 273.)

204. THIOCYANIC ACID, 6(?)BROMO-ISOPHTHALAL ESTER,



Synonyms: Omega, omega, omega prime, omega prime-Tetrathiocyano-p-(?) bromo-m-xylene; omega, omega, omega prime, omega prime-Tetrarhodan-p-(?) brom-m-xylol

Used as a 2 percent dusting powder at the rate of 0.16 mg. per sq.-cm. of leaf surface, and using 100 plant lice in each case, this compound gave the following results in 24 hours:

Dead	80	84	87
Crippled	0	1	4
Living	20	15	9

(German patent 548,091.)



205. THIOCYANIC ACID, 2-(2'-BUTOXYETHOXY) ETHYL ESTER,  $C_4H_9OCH_2CH_2OCH_2CH_2SCN$

About 1 g. of the compound is dissolved in sufficient organic solvent, e. g. kerosene, to make the total volume 100 cc. If the resulting solution is sprayed in a room containing flies, the flies are practically completely eliminated within a very short period. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

A solution of about 1 g. of the beta-thiocyano derivative of the mono-butyl ether of diethyleneglycol in sufficient organic solvent to make 100 cc., when sprayed in a room containing flies, kills all the flies in 5 minutes. (German patent 562,672.)

206. THIOCYANIC ACID, 2-BUTOXYETHYL ESTER,  $C_4H_9OCH_2CH_2SCN$

Synonym: beta-thiocyanoethyl butyl ether

This compound can be satisfactorily employed in solutions or mixtures of considerable dilution as an insecticide. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326.)

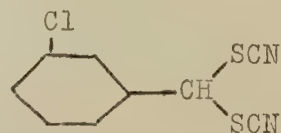
207. THIOCYANIC ACID, n-BUTYL ESTER,  $CH_3CH_2CH_2CH_2SCN$

B.p. 180-183° C.

In fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons, a concentration of 3.8 mg. per liter in conjunction with 1.5 mg. per liter of hydrocyanic acid for 25 minutes at 25° C. gave a scale survival (resistant stages) of 2.7 percent. Scale exposed to a saturated atmosphere for 25 minutes at 25° C. showed a survival of 71 percent. (Cupples et al., 2.)

An aqueous spray containing 0.1 percent of n-butyl thiocyanate and 0.5 percent of a spreader (Tanoyl) killed 33.3 and 31.0 percent of Aphis rumicis on nasturtiums. The spreader (Tanoyl) alone killed 23.1 and 22.5 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 272.)

208. THIOCYANIC ACID, m-CHLOROBENZAL ESTER,



Synonyms: m-chlorobenzalthiocyanate; m-Chlorobenzalrhodanid

Used as a 2 percent dusting powder at the rate of 0.16 mg. per sq.-cm. of leaf surface, and using 100 plant lice, m-chlorobenzalthiocyanate gave the following results in 24 hours:

Dead	55	59
Crippled	0	1
Living	45	40

(German patent 548,091.)

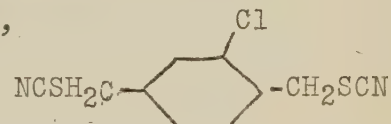
m-Chlorobenzalithiocyanate used a 2 percent dusting powder at the rate of 0.16 mg. per sq.-cm. of leaf surface killed 55 out of 100 plant lice. (German patent 545,740.)

209. THIOCYANIC ACID, CHLOROBENZYL ESTER,



A 1 percent solution of chlorobenzylthiocyanate in carbon tetrachloride is an active agent for exterminating flies and gnats in closed rooms. (German patent 520,330.)

210. THIOCYANIC ACID, 2-CHLORO-6-METHOXY-p-XYLYL ESTER,



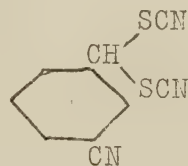
Synonyms: 1-methoxy-3-chloro-4,6-xylyldithiocyanate; 1-Methoxy-3-chlor-4,6-xylyl-dirhodanid

1-Methoxy-3-chloro-4,6-xylyldithiocyanate used as a 2 percent dusting powder at the rate of 0.16 mg. per sq.-cm. of leaf surface killed 17 out of 100 plant lice. (German patent 545,740.)

Five-tenths part of 1-methoxy-3-chloro-4,6-xylyldithiocyanate dissolved in acetone, a wetting agent added and made up to 1000 parts with water, equals nicotine in its action on plant lice on green plants. At a concentration of 0.1 percent it kills 100 percent of green plant lice on cineraria, cucumber, etc. (German patent 501,135.)

Five-tenths part by weight of the reaction product from 1-methoxy-3-chloro-4,6-xylyldichloride and ammonium thiocyanate is dissolved to 1000 parts by weight and used for the destruction of leaf lice on green plants. The action of the product in this concentration reaches that of nicotine. A 0.1 percent emulsion killed 100 percent of green plant lice on cineraria. (British patent 325,910.)

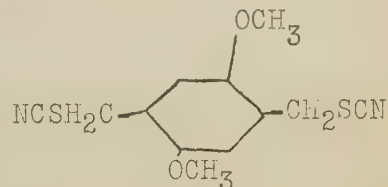
211. THIOCYANIC ACID, m-CYANOBENZAL ESTER,



Synonyms: m-Cyanobenzalithiocyanate; m-Cyanobenzalrhodanid

M-Cyanobenzalithiocyanate is an active insecticide harmless to plants. (German patent 545,740.)

212. THIOCYANIC ACID, 2,5-DIMETHOXY-p-XYLYL ESTER,



Synonyms: 1,4-dimethoxy-2,5-xylyldithiocyanate; 1,4-Dimethoxy-2,5-xylyldirhodanid

M.p. 173°

One part of 1,4-dimethoxy-2,5-xylidithiocyanate is dissolved in 4 parts of acetone, a wetting agent, e. g. soap, added, and the solution diluted to 1000 parts with water. The resulting emulsion, even at a concentration of 0.2 to 0.3 percent of the dithiocyanate, entirely eradicates green plant lice on green plants such as cineraria or cucumber, without harming the plants. (German patent 501,135.)

One part by weight dissolved in 4 parts by weight of acetone, to which a wetting agent soluble in acetone, (e. g. isobutyl-naphthalenesulphonic acid), is added, and diluted with water to 1000 parts by weight, kills plant lice on green plants without injury to the plants. (British patent 325,910.)

213. THIOCYANIC ACID, p-DIMETHYLAMINOPHENYL ESTER,



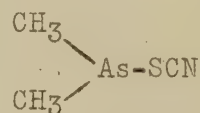
Synonym: p-Thiocyano-N-dimethylaniline

M.p. 71-73° C.

A mixture of 10 parts of p-thiocyanodimethyl aniline and 90 parts of inert solid material, e. g. calcium carbonate, talc or kieselguhr, kills insects, e. g. clothes moths, in a very short time when brought into contact with them. (German patent 562,672.)

The toxicity to goldfish at various concentrations was tested and the results expressed in the form of a survival time curve. A typical rectangular hyperbolic curve was obtained. At concentrations of about  $2.8 \times 10^{-5}$  mole per liter and up the fish were killed in about 60-90 minutes. Below that concentration the toxicity decreases rather rapidly and practically disappears at about  $0.4 \times 10^{-5}$  mole per liter. (Drake and Busbey, 3.)

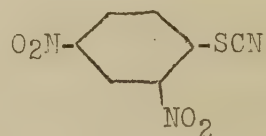
214. THIOCYANIC ACID, DIMETHYL ARSENO DERIVATIVE,



Synonyms: cacodylthiocyanate; Kakodylrhodanid

Cacodylthiocyanate is used as an insecticide. (German patent 520,330.)

215. THIOCYANIC ACID, 2,4-DINITROPHENYL ESTER,



M.p. 139° C.

2,4-Dinitrothiocyanobenzene possesses insecticidal properties. (German patent 562,672.)



216. THIOCYANIC ACID, 2-(2'-ETHOXYETHOXY) ETHYL ESTER,  $C_2H_5OCH_2CH_2OCH_2CH_2SCN$

Synonym: thiocyanate of the monoethyl ether of diethylene glycol

About 1 g. of the compound is dissolved in sufficient water to make the total volume 100 cc. A small amount, e. g. 1/2 percent, of neutral soap may be added. If the resulting solution is sprayed in a room containing flies, the flies are usually practically completely eliminated in a very short period, e. g. 5 minutes. (U. S. patent 1,808,893; British patent 361,900; French patent 696,326; German patent 562,672.)

217. THIOCYANIC ACID, 2-ETHOXYETHYL ESTER,  $CH_3CH_2OCH_2CH_2SCN$

Synonym: beta-thiocyanoethyl ethyl ether

An aqueous spray containing 0.1 percent of beta-thiocyanoethyl ethyl ether and 0.5 percent of Penetrol killed 71.0 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 47.2 and 34.3 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 273.)

218. THIOCYANIC ACID, ETHYL ESTER,  $CH_3CH_2SCN$

Synonym: Äthylrhodanid

B.p. 144.4° C.

Ethyl thiocyanate admixed with 0.2 percent HCN in air shortened the time required for 100 percent kill of ladybird beetles (Hippodamia convergens Guerin) to 15 minutes or less. Two-tenths percent HCN alone required 25 minutes. (Pratt et al., 15.)

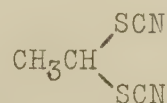
In fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons, a dosage of 3.5 mg. per liter for 25 minutes at 25° C. gave a scale survival (all stages) of 33 percent. A dosage of 4.8 mg. per liter for 25 minutes at 25° C. killed all of the scale. (Cupples et al., 2.)

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 100 mg./liter. (Roark and Cotton, 18.)

The lethal concentration as a fumigant in glass flasks against the rice weevil (S. oryza L.) is 2 lbs./1,000 cu. ft. and against the granary weevil (S. granarius L.) 2-1/2 lbs./1,000 cu. ft; against the flour weevil (Tribolium confusum Fab.) 2 lbs./1,000 cu. ft. (Neifert et al., 13, p. 8.)

A mixture of 5 cc. ethylthiocyanate and 10 cc. Turkey red oil is used as a 1 to 2 percent spray against animal pests. (German patent 520,330.)

219. THIOCYANIC ACID, ETHYLIDENE ESTER,



Synonym: Äthylidenrhodanid

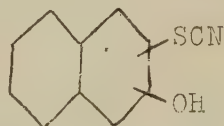
Ethylidenethiocyanate is an active insecticide harmless to plants. (German patent 545,740.)

220. THIOCYANIC ACID, GUANIDINE SALT,  $\text{NH}_2\text{C}(=\text{NH})\text{NH}_3\text{SCN}$

Synonym: Rhodanguanidin

Roots dipped in a 0.5 percent aqueous solution of thiocyanoguanidine still contained live lice after 23 hours. In a 4 percent solution they still contained a few live lice after 17 hours. (Hollrung, 6, p. 322.)

221. THIOCYANIC ACID, HYDROXYNAPHTHYL ESTER,

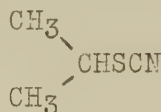


Synonyms: thiocyanohydroxynaphthalene; Rhodanoxy-naphthalin; Hydroxynaphthalenethiocyanate

Thiocyanohydroxynaphthalene is very active in destroying insects. (U. S. patent 1,794,046; Dutch patent 21,982; French patent 654,416.)

Oxynaphthalene thiocyanates possess insecticidal properties. (British patent 317,525.)

222. THIOCYANIC ACID, ISOPROPYL ESTER,



Synonyms: Thiocyansaure-isopropylester; Isopropylrhodanid

B.p. 149-151°

The minimum concentration, 19 mg./liter, tested as a fumigant against rice weevils (Sitophilus oryza L.) in wheat killed 100 percent in 24 hours. (Roark and Cotton, 18, p. 33.)

In fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons, a dosage of 6.3 mg. per liter for 25 minutes at 25° C. gave a scale survival (all stages) of 40 percent. (Cupples et al., 2.)

223. THIOCYANIC ACID, 2-(2'-METHOXYETHOXY) ETHYL ESTER,  $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{SCN}$

Synonym: beta-thiocyano derivative of the monomethylether of diethyleneglycol

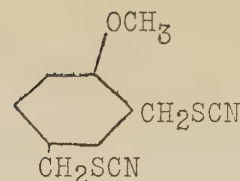
The beta-thiocyano derivative of the monomethyl ether of diethylene-glycol possesses insecticidal properties. (German patent 562,672.)

224. THIOCYANIC ACID, 2-METHOXYETHYL ESTER,  $\text{CH}_3\text{OCH}_2\text{CH}_2\text{SCN}$

Synonym: beta-thiocyanoethyl methyl ether

An aqueous spray containing 0.1 percent of beta-thiocyanoethyl methyl ether and 0.5 percent of Penetrol killed 86.7 and 86.5 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 16.2 and 21.3 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 273.)

225. THIOCYANIC ACID, 6-METHOXY-m-XYLYL ESTER,



Synonyms: 1-methoxy-2,4-xylyldithiocyanate; 1-Methoxy-2,4-xylyldi-rhodanid

M. p. 71-72°

One part of 1-methoxy-2,4-xylyldithiocyanate is dissolved in 4 parts of acetone, a wetting agent, e. g. soap, added, and the solution diluted to 1000 parts with water. The resulting emulsion, even at a concentration of 0.2 to 0.3 percent of the dithiocyanate, entirely eradicates green plant lice on green plants such as cineraria or cucumber, without harming the plants. (German patent 501,135.)

One part of the substance (by weight) is dissolved in 4 parts of acetone, to which a wetting agent soluble in acetone, (e. g. isobutyl-naphthalene-sulphonic acid), is added and the solution is diluted with water to 1000 parts by weight. The emulsion thus obtained kills plant lice on green plants without injury to the plants. A 0.25 percent emulsion killed 100 percent of green plant lice on cucumber. A 0.3 percent emulsion killed 100 percent of green plant lice on cineraria. (British patent 325,910.)

226. THIOCYANIC ACID, METHYL ESTER,  $\text{CH}_3\text{SCN}$

Synonyms: Thiocyanssäure-methylester; Rhodanmethan; methylthiocyanate; Methylrhodanid

B.p. 133°

The m. l. d. as a fumigant against rice weevils (Sitophilus oryza L.) exposed 24 hours in wheat is 64 mg./liter. (Roark and Cotton, 18.)

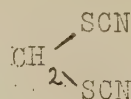
The lethal concentration as a fumigant against the rice weevil (S. oryza L.) is 0.2 lb./1,000 cu. ft., against the granary weevil (S. granarius L.) 0.3 lb./1,000 cu. ft., and against the flour weevil (Tribolium confusum Fab.) 0.3 lb./1,000 cu. ft. (Neifert et al., 13, p. 8.)

In fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons, a dosage of 6.6 mg. per liter for 30 minutes at 25° C. with 1.5 mg. per liter of hydrocyanic acid during the last 24 minutes gave a scale survival (resistant stages) of 0.9 percent. A dosage of 10 mg. per liter for 25 minutes at 25° C. gave a scale survival (all stages) of 0.3 percent. Methyl thiocyanate and hydrocyanic acid appear about equally effective in killing red scale, molecule for molecule, with methyl thiocyanate having the superior efficiency in obtaining a complete kill. In some tests on citrus nursery stock, methyl thiocyanate proved inferior to hydrocyanic acid because of greater injury to the foliage. (Cupples et al., 2.)



An aqueous spray containing 0.1 percent of methyl thiocyanate and 0.5 percent of a spreader (Tanoyl) killed 64.3 and 43.2 percent of Aphis rumicis on nasturtium. The spreader alone killed 23.5 and 18.0 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 272.)

227. THIOCYANIC ACID, METHYLENE ESTER,



Synonym: Methylenrhodanid

M.p. 102° C.

Methylenethiocyanate is an active insecticide, harmless to plants. (German patent 545,740.)

228. THIOCYANIC ACID, 4-METHYLTHIOLEENZYL ESTER,



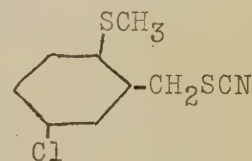
Synonym: 1-Methylthiol-4-rhodanmethylbenzol

Twenty-five hundredths part of 4-methylthiol-benzylthiocyanate was dissolved in 1 part of acetone containing a wetting agent and diluted to 1000 parts with water. The following results were obtained against plant lice on green leaves in 3 days:

Percent active substance	Action on plant lice
0.025	All killed without damage to leaves
0.02	"

(German patent 506,085; U. S. patent 1,841,458.)

229. THIOCYANIC ACID, 2-METHYLTHIOL-5-CHLOROBENZYL ESTER,

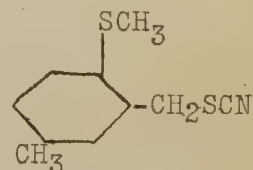


Synonym: 1-Methylthiol-4-chlor-2-rhodanmethylbenzol

M.p. 60°

This substance alone at a concentration of 0.5 percent was active against plant lice on cucumber. When emulsified with "nekalsauem ammonium" it was active against lice on rose leaves at 0.125 percent without damaging the leaves. (German patent 506,085; U. S. patent 1,841,458.)

230. THIOCYANIC ACID, 2-METHYLTHIOL-5-METHYLBENZYL ESTER,



Synonym: 1-Methylthiol-4-methyl-2-rhodanmethylbenzol

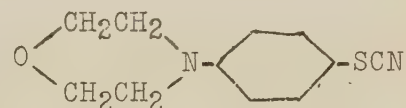
M.p. 55°

Four-tenths part of 2-methylthiol-5-methylbenzylthiocyanate was dissolved in 2 parts of acetone containing a wetting agent, and diluted to 100 parts with water. The following results were obtained against plant lice on green leaves in 3 days:

Percent active substance	Action on plant lice
0.015	Entirely killed without damage to leaves
0.012	"
0.045	"
0.125	"
0.25	"

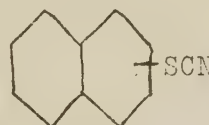
The action of this material at a concentration of 0.015 percent is equalled by nicotine only at 0.06 percent. (German patent 506,085; U. S. patent 1,841,458.)

231. THIOCYANIC ACID, p-MORPHOLINE PHENYL ESTER,



p-Thiocyanophenylmorpholine possesses insecticidal properties. (German patent 562,672.)

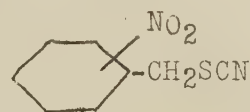
232. THIOCYANIC ACID, NAPHTHYL ESTER,



Synonym: Naphthylrhodanid

Naphthylthiocyanate is an active contact poison and repellent for insects. (German patent 520,330.)

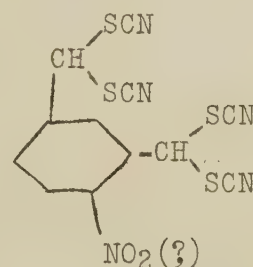
233. THIOCYANIC ACID, NITROBENZYL ESTER,



Synonym: Nitrobenzylrhodanid

Two parts of nitrobenzylthiocyanate triturated with a mixture of 5 parts of liquid coumarone resin and 95 parts of ashes serves to combat ants. (German patent 520,330.)

234. THIOCYANIC ACID, 6(?) -NITRO-ISOPHTHALAL ESTER,



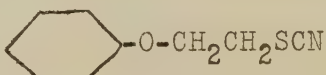
Synonyms: omega, omega, omega prime, omega prime-tetrathiocyanop- (?) nitro-m-xylene; omega, omega, omega prime, omega prime-tetrarhodan-p- (?) nitro-m-xylol

Used as a 2 percent dusting powder at the rate of 0.16 mg. per sq.-cm. of leaf surface, this compound killed 82 out of 100 plant lice in 24 hours. At the rate of 0.32 mg. per sq.-cm. it killed 11 out of 20 caterpillars in 24 hours. (German patent 548,091.)

235. THIOCYANIC ACID, 2-OCTYL ESTER,  $\text{CH}_3(\text{CH}_2)_5\text{CHCH}_3$   
SCN

Synonym: 2-thiocyanooctane

An aqueous spray containing 0.1 percent of 2-thiocyanooctane and 0.5 percent of Penetrol killed 37.3 and 52.8 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 25.3 and 13.9 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 273.)

236. THIOCYANIC ACID, 2-PHENOXYETHYL ESTER, 

Synonym: beta-thiocyanoethyl phenyl ether

An aqueous spray containing 0.1 percent of beta-thiocyanoethyl phenyl ether and 0.5 percent of Penetrol killed 93.6 and 94.5 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 43.8 and 45.8 percent of the aphids. The beta-thiocyanoethyl phenyl ether caused slight injury to the nasturtium plants. (Hartzell and Wilcoxon, 5, pp. 271, 273.)

237. THIOCYANIC ACID, 3-PHENOXYPROPYL ESTER, 

Synonym: gamma-thiocyanopropyl phenyl ether

An aqueous spray containing 0.1 percent of gamma-thiocyanopropyl phenyl ether and 0.5 percent of Penetrol killed 98.0 and 93.7 percent of Aphis rumicis on nasturtium. The Penetrol alone killed 28.8 and 22.2 percent of the aphids. Of 15 organic thiocyanogen compounds tested, gamma-thiocyanopropyl phenyl ether was the most satisfactory considering both toxicity to Aphis rumicis and injury to foliage. The solution mentioned above was used to spray young coleus (Coleus blumei Benth.) plants badly infested with mealy bug (Pseudococcus citri Risso) and gave a kill of 98.0 percent without injury to the plants. The same spray gave a kill of 100.0 percent of red spider mite (Tetranychus telarius L.) on rose (Rosa sp.) without injury to the plants. The following plants were sprayed with the solution: nasturtium (Tropaeolum minus L.), petunia (Petunia axillaris BSP.), English ivy (Hedera helix L.), eggplant (Solanum melongena L. var. esculentum L.), balsam (Impatiens balsamina L.), Jerusalem cherry (Solanum pseudocapsicum L.), cabbage (Brassica oleracea L. var. capitata L.), potato (Solanum tuberosum L.), peach seedlings (Prunus persica [L.] Stokes), shining club-moss (Lycopodium lucidulum Michx.), geranium (Pelargonium sp.), buckwheat (Fagopyrum esculentum Moench), gladiolus (Gladiolus sp.), African marigold (Tagetes erecta L.), cosmos (Cosmos bipinnatus Cav.), salvia (Salvia splendens Ker.), heliotrope (Heliotropium peruvianum L.), and cotton (Gossypium hirsutum L.). No injury to foliage was observed except in the case of buckwheat.



Tests with the cockroach (Periplaneta americana L.) and with meal worm larvae (Tenebrio molitor L.) showed that this compound causes injury to the central nervous system accompanied by paralysis. (Hartzell and Wilcoxon, 5, pp. 272, 274.)

238. THIOCYANIC ACID, PHENYL ESTER,



Synonym: benzene thiocyanate

B.p. 232° C.

Phenylthiocyanate possesses insecticidal properties. (German patent 562,672.)

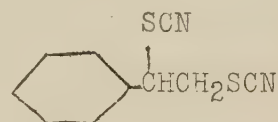
The toxicity to goldfish at various concentrations was tested and the results expressed in the form of a survival time curve. A typical rectangular hyperbolic curve was obtained. At concentrations of about  $2.9 \times 10^{-5}$  mole per liter and above the fish were killed in about 30-90 minutes. Below that concentration the toxicity decreased rather rapidly, disappearing at about  $0.7 \times 10^{-5}$  mole per liter. (Drake and Busbey, 3.)

Used as a spray against plant lice, 0.5 percent of phenylthiocyanate killed all the lice while with 0.33 percent a few survived. A calcium arsenate dusting powder, which contained an adhesive agent, was mixed with 0.1 percent phenylthiocyanate. The thiocyanate had a corrosive action on the mucous membrane and prevented the taking of the arsenical by higher animals. (German patent 520,330.)

An insecticide contains 5 parts of benzene thiocyanate and 95 parts of talc powder. (U. S. patent 1,794,046.)

An aqueous spray containing 0.1 percent of phenyl thiocyanate and 0.5 percent of a spreader (Tanoyl) killed 24.5 and 23.4 percent of Aphis rumicis on nasturtium. The spreader alone killed 16.3 and 20.8 percent of the aphids. (Hartzell and Wilcoxon, 5, p. 272.)

239. THIOCYANIC ACID, 1-PHENYL-2-THIOCYANOETHYL ESTER,



Synonyms: styroldithiocyanate; styrenedithiocyanate; styroldirhodanid

M.p. 101-102° C.

Styroldithiocyanate possess insecticidal properties. (British patent 317,525.)

A mixture of 5 parts of styroldithiocyanate and 95 parts of talc forms a dusting agent that suffices to kill in a very short time the larvae and imagines of Piesma quadrata. (U. S. patent 1,815,816; Dutch patent 21,982; French patent 654,416.)

240. THIOCYANIC ACID, PICOLINE ESTER,  $C_5H_4NCH(SCN)_2$

Synonym: Picolindirhodanid

Picolinedithiocyanate is an active insecticide harmless to plants. (German patent 545,740.)

241. THIOCYANIC ACID, 2-(2'-PROPOXYETHOXY) ETHYL ESTER,  $C_5H_7OCH_2CH_2OCH_2CH_2SCN$

Synonym: beta-thiocyano derivative of the monopropylether of diethylene glycol

The beta-thiocyano derivative of the monopropyl ether of diethylene glycol possesses insecticidal properties. (German patent 562,672.)

242. THIOCYANIC ACID, PYRIDYL ESTER,



Pyridylthiocyanate is an active contact poison and repellent for insects. (German patent 520,330.)

243. THIOCYANIC ACID, TEREPHTHALAL ESTER,



Synonyms: Omega,omega,omega prime,omega prime-tetrathiocyano-p-xylylene; omega,omega,omega prime, omega prime-tetrarhodan-p-xylool

Used as a 2 percent dusting powder at the rate of 0.16 mg. per sq.-cm. of leaf surface, and using 100 plant lice in each case, this compound gave the following results in 24 hours:

Dead	70	78	80
Crippled	5	10	11
Living	25	12	9

(German patent 548,091.)

244. THIOCYANIC ACID, 2-THIOCYANO ETHYL ESTER,  $NCSCH_2CH_2SCN$

Synonyms: ethylene dithiocyanate; Äthylendirhodanid

M. p. 90° C.

Ethylene dithiocyanate possesses insecticidal properties. (British patent 317,525.)

A mixture of 5 parts of ethylenedithiocyanate and 95 parts of talc are mixed to form a dusting agent. This suffices to kill in a very short time the larvae and imagines of Piesma quadrata. (U. S. patent 1,815,816; Dutch patent 21,982; French patent 654,416.)

245. o,m,p-XYLENES, OMEGA, OMEGA-TETRATHIOCYANO-,

Synonyms: o,m,p-omega-tetrathiocyanoxylenes; o,m,p-omega, omega-Tetrarhodanxylole

o,m,p-omega, omega-Tetrathiocyanoxylenes or their halogen, hydroxy, alkoxy, acyloxy, cyano or amino derivatives are especially active insecticides. (German patent 548,091.)

REACTION PRODUCTS OF UNKNOWN STRUCTURE FROM HALOGENATED KETONES AND ALKALI METAL THIOCYANATES.

246. ACETONE, CHLORO-, REACTION PRODUCT WITH POTASSIUM THIOCYANATE.

A 5 percent trituration of the reaction product of chloroacetone and potassium thiocyanate with silicified tobacco serves as a dusting agent. (German patent 553,856.)

247. ACETONE, ALPHA, ALPHA-DICHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of alpha,alpha-dichloroacetone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

248. ACETONE, ALPHA, ALPHA PRIME-DICHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of alpha,alpha prime-dichloroacetone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

249. ACETOPHENONE, OMEGA-BROMO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of omega-bromoacetophenone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

250. ACETOPHENONE, OMEGA-BROMO-p-CHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of omega-bromo-p-chloroacetophenone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

251. ACETOPHENONE, OMEGA-BROMO-3,4-DIHYDROXY-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of omega-bromo-3,4-dihydroxyacetophenone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)



252. ACETOPHENONECARBOXYLICACID, OMEGA-BROMO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of omega-bromoacetophenonecarboxylic acid and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

253. ALKALI METAL THIOCYANATES, REACTION PRODUCTS WITH HALOGENATED KETONES.

The products of reaction between an alkali thiocyanate and halogenated ketones in an organic solvent are very active insecticides. Ketones specifically mentioned are chloroacetone, alpha,alpha-dichloroacetone, alpha,alpha prime-dichloroacetone, alpha,alpha prime-dichloromethylethylketone, alpha,alpha-dichloromethylethylketone, alpha,beta prime-dichloromethylethylketone, bromoisovalerylketone, alpha,alpha-dichlorodiethylketone, dichlorocyclohexanone, bromomethylcyclohexanone, dichlorodiacetonealcohol, trichloromesityloxiide, chlorinated phorone, chlorocamphor, omega-bromoacetophenone, omega-bromo-p-chloroacetophenone, omega-bromo-3,4-dihydroxyacetophenone, omega-bromoacetophenonecarboxylic acid, chloropyrazolone. (German patent 553,856.)

254. 2-BUTANONE, 1,1-DICHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of alpha,alpha-dichloromethylethylketone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

255. 2-BUTANONE, 1,3-DICHLORO-, REACTION PRODUCT WITH SODIUM THIOCYANATE.

A 10 percent solution of the reaction product of alpha, alpha prime-dichloromethylethylketone and sodium thiocyanate in 50 percent acetone is sprayed in 1 percent solution. (German patent 553,856.)

256. 2-BUTANONE, 1,4-DICHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of alpha, beta prime-dichloromethylethylketone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

257. CAMPHOR, CHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of chlorocamphor and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

258. CYCLOHEXANONE, BROMOMETHYL-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of bromomethylcyclohexanone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

259. CYCLOHEXANONE, DICHLORO-, REACTION PRODUCT WITH SODIUM THIOCYANATE.

A mixture of 5 parts of the reaction product of dichlorocyclohexanone with sodium thiocyanate in 45 parts of coal-tar oil, emulsified with Turkey red oil and rosin soap, is sprayed in a 1 to 5 percent emulsion. (German patent 553,856.)

260. ISOVALERYLKETONE, BROMO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of bromoisovalerylketone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

261. MESITYLOXIDE, TRICHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of trichloromesityloxide and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

262. 2-PENTANONE, 4-HYDROXY-4-METHYL-DICHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

Synonym: Dichlorodiacetonealcohol

The reaction product of dichlorodiacetonealcohol and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

263. 3-PENTANONE, 2,2-DICHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of alpha,alpha-dichlorodiethylketone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

264. PHORONE, CHLORINATED, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of chlorinated phorone and an alkali thiocyanate in alcohol and acetone is a very active insecticide. (German patent 553,856.)

265. PYRAZOLONE, CHLORO-, REACTION PRODUCT WITH ALKALI THIOCYANATE.

The reaction product of chloropyrazolone and an alkali thiocyanate in alcohol or acetone is a very active insecticide. (German patent 553,856.)

ISOTHIOCYANATES

266. ISOTHIOCYANIC ACID, ALLYL ESTER,  $\text{CH}_2=\text{CHCH}_2\text{NCS}$

Synonyms: mustard oil; Senföl; Allylsenföl

B.p. 150.7° C.

A mixture of 1 kg. mustard oil, 5 kg. distilled spirits and 1000-2000 kg. of "Moosschleim" (made by heating Iceland moss in water for 1 hour at the rate of 2 kg. moss to 100 liters water,) is recommended for use on fruit trees and vines. (Hollrung, 6, p. 323.)

Twelve-hundredths mg. per liter of allyl isothiocyanate were required to kill house flies (Musca domestica L.) in 400 minutes. (Moore, 9.)

The concentration of allyl isothiocyanate toxic to wireworms (genus Agriotes) is 0.074 to 0.039 mg. per liter of air [0.75 to 0.4 millionths of a gram molecule per liter] in 1000 minutes at 15° C. (pp. 204, 208.) This was the most toxic compound tested. (Tattersfield and Roberts, 20.)

The addition of an irritant such as mustard oil to hydrocyanic acid in fumigating stimulates molting insects to greater respiratory activity, thus increasing the efficiency of the process. The irritant also has a toxic power against insects. (U. S. patent 1,381,586.)

Allyl isothiocyanate on fresh beef liver was repellent to screw-worm flies (Cochliomyia macellaria Fab.). When mixed with mineral oil, petrolatum or kaolin it appeared a stronger repellent than when undiluted. (Parman et al., 15, pp. 14, 25.)

Allyl isothiocyanate was repellent to house flies (Musca domestica L.), green bottle flies (Lucilia spp.) and black blowflies (Phormia regina Meig.). Mixtures with kaolin (1:3) and with petrolatum (1:2) were also repellent to M. domestica and Lucilia spp. (Laake et al., 7, pp. 4, 8.)

The vapor of mustard oil in air of 70 percent relative humidity was more toxic than carbon disulphide to naked Japanese beetle larvae. In moist soil infested with larvae, however, mustard oil did not penetrate in effective concentration beyond a thin superficial layer of soil.

Mustard oil was more toxic to naked Japanese beetle larvae immersed in a solution of it at 65° F. for 24 hours than was carbon disulphide. (Fleming, 4, pp. 814, 815.)

The median lethal concentration (amount necessary to kill 50 percent) as a fumigant for wireworms (Limoni (Pheletes) californicus Mann.) was 0.16 mg. per liter. The relative toxicity compared to carbon disulphide was 192.9. (Lehman, 8, p. 1050.)

Allyl isothiocyanate at a concentration of 0.20 percent, (by weight) in air gave a partial kill of ladybird beetles (Hippodamia convergens Guerin) in 30 minutes. One-hundredths percent allyl isothiocyanate admixed with 0.2 percent HCN shortened the time necessary for a 100 percent kill of the beetles to 15 minutes, and 0.05 percent allyl isothiocyanate cut the time to 10 minutes. Two-tenths percent HCN alone required 25 minutes. (Pratt et al., 15.)

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed moderate toxicity both alone and as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

The minimum concentration, 20 mg./liter, tested as a fumigant against rice weevils (Sitophilus oryza L.) in wheat killed 100 percent in 24 hours. (Roark and Cotton, 19, p. 34.)



The minimum concentrations tested as a fumigant and found to kill 100 percent of the rice weevil (*S. oryza* L.), the granary weevil (*S. granarius* L.), and the flour weevil (*Tribolium confusum* Fab.) and the larvae of the Indian meal moth (*Plodia interpunctella* Hbn.) was 0.9 lb./1000 cu. ft. (Neifert et al., 13, pp. 11, 17.)

A mixture of 0.8 lb. allyl isothiocyanate with 5.3 lb.  $\text{CCl}_4$  per 1000 cu. ft. killed all weevils and *Plodia* larvae in a box partly filled with grain. (Neifert et al., 13, p. 23.)

Mixtures of 0.3 lb. and 0.4 lb. allyl isothiocyanate with 12.3 lbs.  $\text{CCl}_4$  per 1000 cu. ft. did not kill all the weevils in wheat in a box car. (Neifert et al., 13, p. 27.)

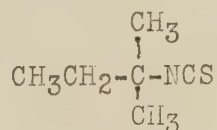
Oil of mustard possesses the property of preventing soil nematode (*Heterodera schachtii*) larvae from slipping out of the cysts until such time as the sugar beets have become strong enough to withstand their attack. It may be placed in the soil in aqueous solution or emulsion or in admixture with an indifferent medium such as kieselguhr or earth. (British patent specification 249,830.)

267. ISOTHIOCYANIC ACID, n-AMYL ESTER,  $\text{n-C}_5\text{H}_{11}\text{NCS}$

B.p. 193.5-196.5° C

The toxicity to goldfish at various concentrations was tested and the results expressed in the form of a survival time curve. A typical rectangular hyperbolic curve was obtained. At the higher concentrations (from about  $2.9 \times 10^{-5}$  mole per liter and above) the fish were killed in about 120 minutes. Below that concentration the toxicity decreased quite rapidly, practically disappearing at about  $0.5 \times 10^{-5}$  mole per liter. (Drake and Busbey, 3.)

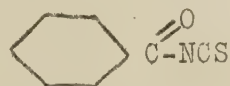
268. ISOTHIOCYANIC ACID, TERT.-AMYL ESTER,



B.p. 164-7° C.

There was no apparent toxicity to goldfish at concentrations of concentrations of  $2.90 \times 10^{-5}$ ,  $3.87 \times 10^{-5}$ ,  $3.88 \times 10^{-5}$ , and  $3.48 \times 10^{-5}$  mole per liter. (Drake and Busbey, 3.)

269. ISOTHIOCYANIC ACID, BENZOYL ESTER,



Synonym: Benzoyl isothiocyanate

B.p. 128-31° at 15 mm.

The toxicity to goldfish at various concentrations was tested and the results expressed in the form of a survival time curve. A typical rectangular hyperbolic curve was obtained. At concentrations of about  $2.5 \times 10^{-5}$  mole per liter and above the fish were killed in about 50-60 minutes. Below that concentration the toxicity decreased and below about  $2 \times 10^{-5}$  mole per liter the results were quite erratic, the toxicity entirely disappearing at a slightly lower concentration. (Drake and Busbey, 3, p. 2935.)

270. ISOTHIOCYANIC ACID, ESTERS.

Various isothiocyanates are toxic to red scale (Chrysomphalus aurantii Mask.) at moderate concentrations. They are more injurious than the thiocyanates to citrus fruit and foliage. (Cupples et al., 2.)

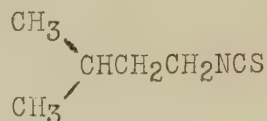
271. ISOTHIOCYANIC ACID, ETHYL ESTER,  $\text{CH}_3\text{CH}_2\text{NCS}$

B.p. 129-31° C.

In fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons, a dosage of 6.6 mg. per liter together with 1.5 mg. per liter of hydrocyanic acid for 25 minutes at 25° C. gave a survival (resistant stages) of 3 percent. In another test a dosage of 7.6 mg. per liter together with 1.5 mg. per liter of hydrocyanic acid for 25 minutes at 25° C. gave a survival of 21 percent. (Cupples et al., 2.)

The minimum concentration, 20 mg./liter, tested as a fumigant against rice weevils (Sitophilus oryza L.) in wheat killed 100 percent in 24 hours. (Roark and Cotton, 18, p. 34.)

272. ISOTHIOCYANIC ACID, ISOAMYL ESTER,



B.p. 190-2° C.

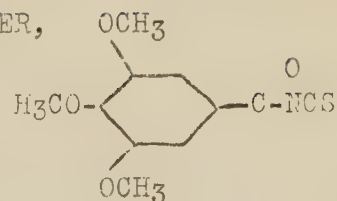
The toxicity to goldfish at various concentrations was tested and the results expressed in the form of a survival time curve. A typical rectangular hyperbolic curve was obtained. At concentrations from about  $3.9 \times 10^{-5}$  mole per liter and above the fish were killed in about 130 minutes. Below that concentration the toxicity decreased rather rapidly, practically disappearing at about  $0.7 \times 10^{-5}$  mole per liter. (Drake and Busbey, 3.)

273. ISOTHIOCYANIC ACID, METHYL ESTER,  $\text{CH}_3\text{NCS}$

B.p. 119° C.

In fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons, a dosage of 7.4 mg. per liter of 1:1 mixture with methyl thiocyanate for 25 minutes at 25° C. gave a scale survival (all stages) of 0.8 percent. (Cupples et al., 2.)

274. ISOTHIOCYANIC ACID, 3,4,5-TRIMETHOXYBENZOYL ESTER,

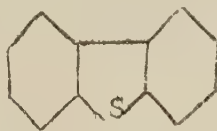


Synonym: trimethylgalloyl isothiocyanate

A concentration of 1:10,000 in water killed 12 percent of culicine mosquito larvae in 9 hours. (Campbell et al., 1.)

#### THIOPHENE DERIVATIVES

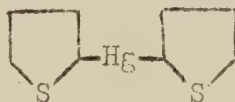
275. DIBENZOTHIOPHENE,



Synonym: diphenylene sulphide

A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. A concentration of 1:40,000 killed 25 out of 50 larvae in 155 minutes, and all 50 in 420 minutes. In another test, 1:40,000 killed 25 out of 50 larvae in 64 minutes and the clear filtrate from the same solution killed 25 out of 50 in 74 minutes. A concentration of 1:100,000 killed 25 out of 50 larvae in 59 minutes and killed all 50 within 8 hours. 1:200,000 killed 25 out of 50 in 62 minutes, and 50 in 8 hours. The material was ineffective as compared to rotenone against Musca domestica, and unpromising as compared to nicotine against Aphis rumicis. However, it was promising as compared to lead arsenate against Prodenia eridania and Ascia rapae. (Campbell et al., 1.)

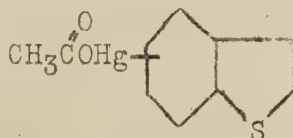
276. DI-2-THIENYL MERCURY,



Synonym: alpha-mercury dithienyl

Two parts of alpha-mercury dithienyl are mixed with 97 parts of calcium sulphate and 1 part of lime. The resulting mixture is a seed disinfectant. (U. S. patent 1,934,803.)

277. THIONAPHTHENE, ACETOXYMERCURI-,



Synonym: acetoxymercuri-benzothiophene

Acetoxymercuri-benzothiophene is a seed disinfectant. (U. S. patent 1,934,803.)



278. THIOPHENE,



B.p. 84° C.

Fumigation tests against red scale (Chrysomphalus aurantii Mask.) on lemons showed slight or no toxicity as an auxiliary gas with hydrocyanic acid. (Cupples et al., 2.)

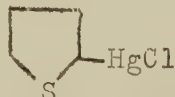
Eight and five hundred ninety-five thousandths mg. per liter of thiophene were required to kill house flies (Musca domestica L.) in 400 minutes. (Moore, 9.)

279. THIOPHENE, 2-ACETOXYMERCURI-5-HYDROXYMERCURI,



One part of 2-acetoxymercuri-5-hydroxymercurithiophene and 0.5 part of mercurized chlorophenol are intimately mixed with 96.5 parts of infusorial earth and 2 parts of charcoal. This dry mixture is a seed disinfectant. (U. S. patent 1,934,803.)

280. THIOPHENE, 2-CHLOROMERCURI-,

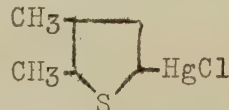


Synonym: alpha-chloromercuri thiophene

One and five-tenths parts of alpha-chloromercuri thiophene are intimately mixed with 97.5 parts of calcium carbonate and 1 part charcoal. The mixture obtained, when used for dusting seeds, gives control of many seed borne diseases.

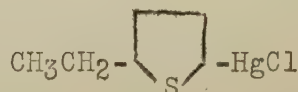
One part of alpha-chloromercuri thiophene and 0.5 part of 2,5-dichloromercuri thiophene are intimately mixed with 96.5 parts of bentonite and 2 parts of charcoal. This product, dusted on seeds, controls seed born diseases. It can also be suspended in water and used for the wet treatment of seeds or other plant products. (U. S. patent 1,934,803.)

281. THIOPHENE, 2-CHLOROMERCURI-4,5-DIMETHYL-,



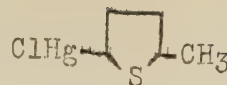
2-Chloromercuri-4,5-dimethyl thiophene is a seed disinfectant. (U. S. patent 1,934,803.)

282. THIOPHENE, 2-CHLOROMERCURI-5-ETHYL,



2-Chloromercuri-5-ethylthiophene is a seed disinfectant. (U. S. patent 1,934,803.)

283. THIOPHENE, 5-CHLOROMERCURI-2-METHYL,



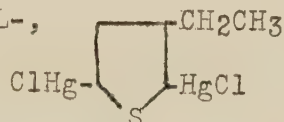
5-Chloromercuri-2-methylthiophene is a seed disinfectant. (U. S. patent 1,934,803.)

284. THIOPHENE, 2,5-DICHLOROMERCURI-,



One part of alpha-chloromercuri thiophene and 0.5 part of 2,5-dichloromercuri thiophene are intimately mixed with 96.5 parts of bentonite and 2 parts of charcoal. This product can be dusted on seeds for the control of seed borne diseases or it can be suspended in water and used for the wet treatment of seeds or other plant products. (U. S. patent 1,934,803.)

285. THIOPHENE, 2,5-DICHLOROMERCURI-3-ETHYL-,



2,5-Dichloromercuri-3-ethylthiophene is a seed disinfectant. (U. S. patent 1,934,803.)

286. THIOPHENE, MERCURY COMPOUNDS.

A finished dry seed disinfectant is made by mixing 96 parts of colloidal clay, 1 part of charcoal, 2.4 parts of mercuric acetate and 0.6 parts of thiophene for 24 hours in a ball mill. The thiophene reacts with mercuric acetate to form a mercurithiophene compound. (U. S. patent 1,934,803.)

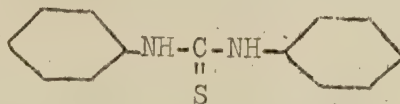
287. THIOPHENES, HALOGENATED, MERCURY COMPOUNDS.

The mercury compounds of halogenated thiophenes are effective seed disinfectants. (U. S. patent 1,934,803.)

THIOUREA DERIVATIVES

Alkyl- and aryl- substituted thioureas

288. CARBANILIDE, THIO-,



Synonyms: s-diphenylthiourea; s-Diphenylsulfoharnstoff

M.p. 150.5° C.

Thiocarbanilide may be used as an insecticidal spray material, e. g., 1 lb. thiocarbanilide in 5 gals water. The suspension is made more stable by the addition of casein, glue, starch solution or other thickener. It may also be used dry for dusting poultry, birds, dogs, cats, etc. Insecticidal compositions claimed are a suspension of thiocarbanilide in water and a suspension of thiocarbanilide and starch in water.

Thiocarbanilide is stated to be effective against the boll weevil, potato bug, cockroach, ants, bedbug, etc. (U. S. patent 1,734,519.)

Thiocarbanilide may be used as an insecticide in the dry state, either alone or mixed with comparatively large amounts of other substances such as starch, flour, magnesium oxide, clay, etc., to serve as a solid diluent or spreader of the active agent. It may also be added to such other insecticides as hellebore, Paris green, lead or calcium arsenate, etc.

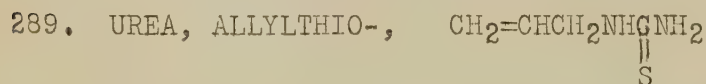
The following compositions may be used: for dusting potato vines, 5 lbs. copper carbonate, 15 lbs. thiocarbanilide, 80 lbs. sulphur; for use on fruit trees, 15 lbs. thiocarbanilide, 85 lbs. sulphur; for dusting poultry and other birds and animals, 20 lbs. thiocarbanilide, 80 parts clay, magnesium oxide, zinc oxide and the like or it is possible to use thiocarbanilide alone or admixed with sulphur or sulphur and hellebore; for use in the household against cockroaches, ants, etc., 25 lbs. thiocarbanilide, 75 lbs. starch or other filler, with or without a sweetening agent or other insecticide. (U. S. patent 1,573,490.)

Four ounces of fine thiocarbanilide were mixed with 1 ounce of flour and 2-4 ounces of fine sulphur and a little water was added gradually with stirring to give a stiff mass with the ingredients thoroughly wetted. This mixture was diluted considerably, 3 gals. of water being added altogether, to produce a suitable liquid for spraying plants and trees.

Up to 3000 parts of water may be used in this mixture. Lime may be substituted for the sulphur, and copper sulphate or copper carbonate may be added to the mixture. (British patent 257,644.)

Thiocarbanilide is claimed to be especially poisonous to beetles and the larvae of moths, making it very efficacious in exterminating potato bugs, boll weevils, etc. The following compositions are mentioned: for dusting potato vines, 5 lbs. copper carbonate, 15 lbs. thiocarbanilide, and 80 lbs. sulphur; for use on fruit trees, 15 lbs. thiocarbanilide and 85 lbs. sulphur; for dusting poultry and other birds and animals, 20 lbs. thiocarbanilide and 80 lbs. clay, magnesium oxide, zinc oxide, or the like, or thiocarbanilide alone or admixed with sulphur or sulphur and hellebore; for use in the household against cockroaches, ants, etc., 25 lbs. thiocarbanilide and 75 lbs. starch or other filler, with or without a small quantity of a sweetening agent or other insecticide. (U. S. patent 1,573,490.)

A mixture of 3 to 10 percent of diphenylthiourea, 0.2 to 1 percent of a wetting agent and/or adhesive and 96.8 to 89 percent of an inert material such as prepared chalk, talc, kieselguhr, etc., may be used for dusting wheat to destroy rust (Puccinia graminis). (French patent 702,703.)



Synonym: Allylthioharnstoff

M. p. 78.4° C.



A concentration of 1:10,000 in water killed 16 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

290. UREA, PHENYLTHIO-,



M.p. 154° C.

A concentration of 1:10,000 in water killed 2 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

291. UREA, THIO-,  $\text{NH}_2\text{C(=S)NH}_2$

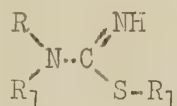
Synonym: Thioharnstoff

M. p. 172° C.

A concentration of 1:10,000 in water killed 8 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

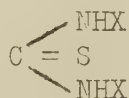
One hour's immersion of seed potatoes in 1 to 2 percent solution of thiourea gave very satisfactory results in preventing hollow heart of potatoes. "Treating cut seed pieces with solutions of thiourea resulted in an increase in number of stems and tubers and a general decrease in the size of the tubers as well as a definite decrease in hollow heart." (Werner, 21.)

292. UREAS, THIO-,



An insecticide is made by incorporating a thiourea or a substituted or disubstituted thiourea with a protective colloid (e. g., flour, gelatin, glue, Irish moss, agar-agar, soap or gum tragacanth) in the dry state and then gradually adding water so as to produce a colloidal suspension therein. (British patent 257,644.)

Thioureas are very destructive to all forms of insect life and may be used in the dry state or applied as a spray. (U. S. patent 1,573,490.)



Thiourea derivatives in which X represents hydrogen or phenyl are used to destroy rust (Puccinia graminis) on wheat by spraying the young wheat with dilute solutions or dusting it with powdered preparations. (French patent 702,703.)

To combat rust (Puccinia graminis) on wheat, it is sprayed with a 0.1 to 0.5 percent solution of thiourea, depending upon the degree of rust and the sensitivity of the variety of wheat. The addition to the solution of substances acting as adhesives or wetting agents is advantageous. Dusting powders may also be used, e. g. 3 to 10 percent of thiourea with 0.2 to 1 percent of a wetting agent and/or adhesive and 96.8 to 99 percent of an inert material such as prepared chalk, talc, kieselguhr, etc. (French patent 702,703.)

#### XANTHATES

293. XANTHATES.  $\text{ROC} \begin{smallmatrix} \nearrow \text{S} \\ \searrow \end{smallmatrix} \text{S-M}$

Here M maybe Na, K, Ca, the radical of an organic base, etc.; R is the radical of hydroxyl compounds obtained by the catalytic vapor oxidation of hydrocarbons such as petroleum, petroleum fractions, shale oil, etc. Tests of these xanthates in the insecticide and fungicide field have shown remarkable results in many desirable characteristics such as spreading quality, killing of insects, not injuring the foliage, etc. Emulsions of xanthated oils may be used as insecticides. (U. S. patent 1,716,273.)

294. XANTHATES, BISALKYL,  $\text{ROC} \begin{smallmatrix} \nearrow \text{S} \\ \searrow \end{smallmatrix} \text{SR}$

Synonym: bisalkylxanthogens

Wood which has been impregnated with bisalkylxanthogens dissolved in organic solvents, e. g. tar oils, by the use of vacuum and pressure, is protected against fungi and bacteria.

Because of the insolubility of the bisalkylxanthogens in water they can be admixed with paints and varnishes for under-water structures and ship bottoms. The activity toward sea organisms is retained for a long time.

Animal parasites, such as mites of all kinds as well as lice on animals and plants, fleas, etc., are killed by very dilute solutions. The xanthogens, being lipoid-soluble, easily penetrate the shell of the eggs and nits and kill them.

Staphylococci and similar bacteria are killed in a short time by 1/4 percent emulsions.

Bisalkylxanthogens may be employed for the cauterization of seeds, in the form of emulsions or mixed with inert materials such as talc or kaolin. (German patent 485,059.)

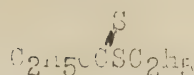
295. XANTHIC ACID, ETHYLENE ESTER,  $\text{C}_2\text{H}_5\text{OC} \begin{smallmatrix} \nearrow \text{S} \\ \searrow \end{smallmatrix} \text{SCH}_2\text{CH}_2\text{SC} \begin{smallmatrix} \nearrow \text{S} \\ \searrow \end{smallmatrix} \text{OC}_2\text{H}_5$

Synonym: ethylene bisethylxanthogen

M.p. 42° C.

Useful for combating plant and animal pests. (German patent 485,059.)

296. XANTHIC ACID, ETHYL ESTER,

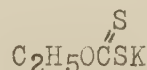


Synonym: bisethyl xanthogen.

B.p. 200° C.

The ratio of the curative dose to the toxic dose of bisethyl xanthogen tested against spores of Tilletia tritici was 0.02; whereas that of formaldehyde was 1.3. (German patent 485,059.)

297. XANTHIC ACID, POTASSIUM SALT,



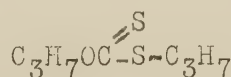
Synonyms: potassium xanthogenate; potassium ethyl dithiocarbonate

Sixteen hundredths percent of potassium xanthate intimately mixed with soil which was infested with Japanese beetle larvae was effective in killing the insects within one week. (Fleming, 4.)

298. XANTHIC ACID, AMYL SODIUM SALT,  $\text{C}_5\text{H}_{11}\text{OC}(=\text{S})\text{S-Na}$

Sodium amylxanthate is used to increase the floatability on water of Paris green for killing Anopheline larvae. It reacts with the surface molecules of the Paris green particles to form a coating of copper amyl xanthate. The mixture recommended is 10 lbs. Paris green, 1.5 oz. sodium amyl xanthate and 4 gals. water. The Paris green is shaken with the water solution of the sodium amyl xanthate. It is then filtered, dried and screened through a 150 mesh sieve. (U. S. patent 1,942,532.)

299. XANTHIC ACID, PROPYL, PROPYL ESTER,

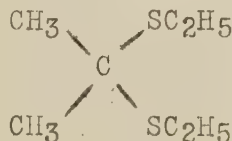


Synonym: Bispropyl xanthogen

Useful for combating plant and animal pests. (German patent 485,059.)

MISCELLANEOUS REACTION PRODUCTS

300. ACETONE DIETHYL MERCAPTOLE,

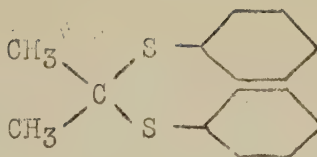


B.p. 191° C.

The maximum concentration, 600 mg./liter, tested as a fumigant against rice weevils (Sitophilus oryza L.) in wheat killed none of the insects in 24 hours. (Roark and Cotton, 18, p. 33.)

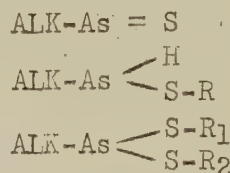


301. ACETONE DIPHENYL MERCAPTOLE,



Mercaptol was found to be so slightly volatile as to be ineffective as a fumigant against the rice weevil, (*Sitophilus oryza* L.), the granary weevil (*S. granarius* L.), and the flour weevil (*Tribolium confusum* Fab.) and *Plodia* larvae. It was tested at a concentration of 1.2 lbs./1000 cu. ft. (Neifert et al., 13, p. 8.)

302. ARSINIC ACIDS, ALKYL, THIO DERIVATIVES,

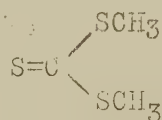


Seed grain is immunized by treating it with thio derivatives of alkyl arsinic acids of the above formulae where R, R<sub>1</sub> and R<sub>2</sub> signify any desired organic residues. (German patent 523,219; British patent 341,366.)

303. BETA-NAPHTHOL, THIO-, CONDENSATION PRODUCT WITH METHYL-ARSINOXIDE.

A mixture of 13.3 g. of the condensation product of methylarsine oxide and beta-thionaphthol with 86.7 g. of talc, dusted on infected grain at the rate of 1:1000, arrests the germination of spores of barley blight. (German patent 523,219; British patent 341,666.)

304. CARBONIC ACID, TRITHIO-, DIMETHYL ESTER,

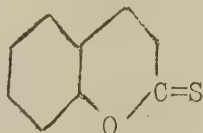


Synonym: dimethyl-trithiocarbonate

B.p. 204.5° C.

The maximum concentration, 600 mg./liter, tested as a fumigant against rice weevils (*Sitophilus oryza* L.) in wheat killed only 20 out of 100 in 24 hours. (Roark and Cotton, 18, p. 33.)

305. COUMARIN, 2-THIO-,



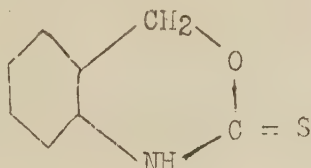
Synonyms: 1-thiocoumarin, 2-thio-1,2-benzopyrone

Extensive practical tests have shown that 2-thio-coumarine furnishes a means of protection against insects, repelling flies, mites, mosquitoes, bed bugs and other insects. (French patent 760,352.)

306. CRESOL, THIOPHOSPHORIC ACID ESTER

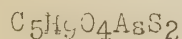
Aerofloat, an ester of thiophosphoric acid and cresol, is used to increase the floatability on water of Paris green for killing Anopheline larvae. (U. S. patent 1,942,532.)

307. CUMAZONE, 2-THIO-,



A concentration of 1:10,000 in water killed 100 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

308. GLYCOLIC ACID, DITHIO-, CONDENSATION PRODUCT WITH ARSENODIMETHYL,



A disinfectant containing 2.4 percent of arsenic in the form of a condensation product of arsenodimethyl and dithioglycolic acid, used at the rate of 4:1000, controlled smut in oats, while 29 percent of the control was infected.

The same mixture dusted on Fusarium infected rye seed at the rate of 2:1000 decreased the infection from 13 percent to 0.7 percent. (German patent 523,219.)

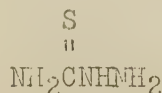
309. PIPERIDINE, ALPHA-METHYL, REACTION PRODUCT WITH CARBON DISULPHIDE.

The reaction product of 2 mols of alpha-methyl piperidine and 1 mol of carbon disulphide at a concentration of 0.25 percent plus 0.5 percent of Perminal when sprayed on aphids killed more than 75 percent after 24 hours. (Australian patent 8103/32.)

310. SALICYLIC ACID, THIO-, CONDENSATION PRODUCT WITH METHYLARSINE OXIDE.

Fusarium infected rye seed treated at the rate of 2:1000 with a mixture of the condensation product of methylarsine oxide and thiosalicylic acid diluted with talc to an arsenic content of 2.4 percent yielded 0.7 percent of diseased plants. The control showed 14 percent infection. (German patent 523,219.)

311. SEMICARBAZIDE, THIO-,



M.p. 183° C.

A concentration of 1:10,000 in water killed 98 percent of culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

312. SULPHIDE, METHYLARSINE,  $\text{CH}_3\text{As} = \text{S}$

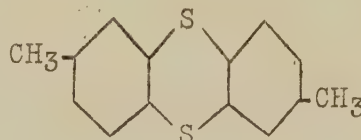
A mixture of 4 parts of methylarsine sulphide and 96 parts of talc dusted on seed grain arrests the germination of barley blight spores. (German patent 523,219; British patent 341,366.)

A preparation containing 2.4 percent arsenic as methylarsine sulphide, dusted on streak diseased barley at the rate of 3:1000, arrested the disease. The control showed an infection of 27 percent. (German patent 523,219.)

313. TETRATHIOPENTONE,  $\text{C}_{15}\text{H}_{28}\text{S}_4$ . (Karasiewicz, Jour. Amer.Chem.Soc., 54:2556.1932)

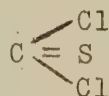
A concentration of 1:10,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

314. THIANTHRENE, 3,7-DIMETHYL-,



A concentration of 1:40,000 in water killed no culicine mosquito larvae in 18 to 24 hours. (Campbell et al., 1.)

315. THIOPHOSGENE,



B.p. 73.5° C.

Thiophosgene showed value as an auxiliary gas with HCN in fumigation tests against ladybird beetles (Hippodamia convergens Guerin). (Pratt et al., 15.)



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